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ABBREVIATED TITLES USED IN THE ABSTRACTS

Abbreviated Title.	*Journal.*
Aircr. Engng	Aircraft Engineering.
Ann. Min. Belg.	Annales des Mines de Belgique.
Ann. Min. Roumanie	Annales des Mines de Roumanie.
Ann. Off. Combust. liq.	Annales de l'Office National des Combustibles Liquides.
Asph. u. Teer	Asphalt und Teer.
Auto. Engr	Automobile Engineer.
Auto. Tech. Z. (Berlin)	Automobiltechnische Zeitschrift (Berlin).
Azerb. neft. Khoz.	Azerbaidzhanskoe Neftyanoe Khozyaistvo.
Beitr. angew. Geophys.	Beitrage angewandte Geophysik.
Beitr. Geophys.	Beitrage zur Geophysik.
Bitumen	Bitumen.
Bohrtech. Z.	Bohrtechniker Zeitung.
Bol. Geol. y Min. (Caracas)	Boletin de Geologia y Mineria (Caracas).
Bol. Inform. Petroleras (B.A.)	Boletin de Informaciones Petroleras (Buenos Aires).
Boll. Soc. geol. ital.	Bolletin de la Societa Geologica Italiana.
Brennst Chemie	Brennstoff Chemie.
Bull. Acad. Sci. (U.S.S.R. Inst. Seismol.)	Bulletin of the Academy of Sciences (U.S.S.R. Institute of Seismology).
Bull. Amer. Ass. Petrol. Geol.	Bulletin of the American Association of Petroleum Geologists.
Bull. Amer. geol. Soc.	Bulletin of the American Geological Society.
Bull. Ass. franç. Tech. Pétrol.	Bulletin de l'Association Français des Techniciens du Pétrole.
Bull. Inst. Min. (metall.) Engrs	Bulletin of the American Institute of Mining and Metallurgical Engineers.
Bull. Math. Phys. Éc. polyt. Bucharest	Bulletin de Mathematique et de Physique, Bucharest (École-polytechnique).
Bull. roum. geol. Soc.	Bulletin of the Roumanian Geological Society.
Bull. seismol. Soc. Amer.	Bulletin of the Seismological Society of America.
Bull. Univ. Texas (Bur. econ. Geol. Techn.)	Bulletin of the University of Texas (Bureau of Economic Geology and Technology).
Bur. Stand. J. Res., Wash.	United States Bureau of Standards Journal of Research, Washington.
Calif. Oil World	California Oil World.
Canad. J. Res.	Canadian Journal of Research.
Canad. Min. J.	Canadian Mining Journal.
Canad. Min. metall. Bull.	Bulletin of the Canadian Institute of Mining and Metallurgy.
Chem. & Ind.	Chemistry and Industry.
Chem. Rev.	Chemical Reviews.
Chem. Tr. J.	Chemical Trade Journal.
Chem. Wkbld	Chemische Weekblad.
Chim. e Industria	La Chimica e l'Industria.
Chim. et Ind.	Chimie et Industrie.
C.R. Acad. Sci. (Paris)	Comptes Rendus hebdomadaires des Seances de l'Academie des Sciences (Paris).
C.R. Geol. Pétr. (Strasbourg)	Compte-Rendu des Seances du Groupe des Geologues Pétroliers de Strasbourg.
II^me Congrès Mond. Pétrole	II^me Congrès Mondial du Pétrole (Paris, 1937).
Diesel Eng. Us. Ass.	Diesel Engine Users Association.
Direccion Minas y Geol.	Publication of Direccion Minas y Geologicas (Argentine).
Econ. Geol.	Economic Geology.
Engineer	Engineer.
Engineering	Engineering.
E.P.	English Patent.
Fuel	Fuel in Science and Practice.
Gas Oil Pwr	Gas and Oil Power.
Geol. Mag. (Lond.)	Geological Magazine (London).
Geophys.	Geophysics.

Abbreviated Title.	*Journal.*
Glückauf	Glückauf.
Groz. Neft.	Groznenskii Neftyanik.
Industr. Engng Chem.	Industrial and Engineering Chemistry.
Industr. Engng Chem. Anal.	Industrial and Engineering Chemistry, Analytical Edition.
Industr. Pwr & Fuel Econ.	Industrial Power and The Fuel Economist.
Instruments	Instruments.
Int. Z. Bohrtech.	International Zeitschrift für Bohrtechnik.
J. Amer. chem. Soc.	Journal of the American Chemical Society.
J. appl. Chem. (U.S.S.R.)	Journal of Applied Chemistry, U.S.S.R.
J. appl. Phys.	Journal of Applied Physics.
J. chem., metall. min. Soc. S. Africa	Journal of the Chemical, Metallurgical and Mining Society of South Africa.
J. chem. Soc.	Journal of the Chemical Society.
J. Fuel Soc. Japan	Journal of the Fuel Society of Japan.
J. Geol.	Journal of Geology.
J. Inst. Fuel	Journal of the Institute of Fuel.
J. Instn auto. Engrs	Journal of the Institution of Automobile Engineers.
J. Inst. Petrol.	Journal of the Institute of Petroleum.
J. org. Chem.	Journal of Organic Chemistry.
J. phys. Chem.	Journal of Physical Chemistry.
J. R. aero. Soc.	Journal of the Royal Aeronautical Society.
J. Soc. aut. Engrs	Journal of the Society of Automotive Engineers.
J. Soc. chem. Ind.	Journal of the Society of Chemical Industry.
Khim. Tverd. Topliva	Khimiya Tverdovo Topliva.
Kop. Naft. Polsce	Kopalnictwo Naftowe w Polsce.
Matières grasses	Matières Grasses.
Min. & Metall.	Mining and Metallurgy.
Min. Mag. (Lond.)	Mining Magazine (London).
Monit. Pétr. roum.	Moniteur du Pétrole Roumain.
Montan. Rdsch.	Montanistische Rundschau.
Nat. Petrol. News	National Petroleum News.
Nature	Nature.
Neft. Khoz.	Neftyanoe Khozyaistvo.
Nickel Ind.	Nickel Industry.
Nov. Neft.	Novosti Neftepererabotki.
Nov. Tekhn. Bur.	Novosti Tekhniki Bureniya.
Nov. Tekhn. Neft.	Novosti Tekhniki Neftedobvicki.
Oel u. Kohle	Oel und Kohle vereinigt mit Erdoel und Teer.
Oil Gas J.	Oil and Gas Journal.
Oil Wkly	Oil Weekly.
Ole, Fette, Wachse	Ole, Fette, Wachse, Seife, Kosmetik.
Olii min.	Olii Minerali.
Paint Mnfr.	Paint Manufacture.
Paint Technol.	Paint Technology.
Petrol. Engr	Petroleum Engineer.
Petrol. Tech. (A.I.M.M.E.)	Petroleum Technology (American Institute of Mining and Metallurgical Engineers).
Petrol. Times	Petroleum Times.
Petrol. World (L.A.)	Petroleum World (Los Angeles).
Petrol. World (Lond.)	Petroleum World (London).
Petrol. Z.	Petroleum Zeitschrift.
Physics	Physics.
Pipe Line News	Pipe Line News.
Proc. Amer. Petrol. Inst.	Proceedings of the American Petroleum Institute.
Proc. Amer. Soc. Test. Mater.	Proceedings of the American Society for Testing Materials.
Proc. Ass. Asph. Pav. Technol.	Proceedings of the Association of Asphalt Paving Technologists.
Proc. Instn mech. Engrs	Proceedings of the Institution of Mechanical Engineers.
Proc. phys. Soc. (Lond.)	Proceedings of the Physical Society (London).
Proc. roy. Soc.	Proceedings of the Royal Society.
Przeg. Chem.	Przeglad Chemiczny.
Przem. Naft.	Przemysl Naftowy.
Quart. J. geol. Soc. Lond.	Quarterly Journal of the Geological Society of London.

Abbreviated Title.	*Journal.*
Rds & Rd Constr.	Roads and Road Construction.
Rec. Trav. chim. Pays-Bas	Receuil des Travaux Chimiques des Pays-Bas.
Refiner	Refiner and Natural Gasoline Manufacturer.
Rev. Comb. liq.	Revue des Combustibles Liquides.
Rev. Pétrolif.	La Revue Pétrolifère.
Rev. sci. Instrum.	Review of Scientific Instruments.
Riv. ital. Petrol.	La Rivista Italiana del Petroleo.
S. Afr. Min. (Engng) J.	South African Mining and Engineering Journal.
Strade	Strade.
Sulz. tech. Rev.	Sulzer Technical Review.
Summ. Ops, Calif. Oil Flds	Summary of Operations, Californian Oil Fields.
Tech. Phys. U.S.S.R.	Technical Physics of the U.S.S.R.
Tekn. Tidskr.	Teknisk Tidskrift.
Terr. Magn.	Terrestrial Magnetism.
Trans. Amer. geophys. Un.	Transactions of the American Geophysical Union.
Trans. Amer. Inst. Min. & Metall.	Transactions of the American Institute of Mining and Metallurgy.
Trans. Faraday Soc.	Transactions of the Faraday Society.
Trans. Inst. mar. Engrs	Transactions of the Institute of Marine Engineers.
Trans. Instn min. Engrs	Transactions of the Institution of Mining Engineers.
U.S. Bur. Mines, Inf. Circ.	United States Bureau of Mines, Information Circular.
U.S. Bur. Mines, Rep. Invest.	United States Bureau of Mines, Report of Investigations.
U.S. Bur. Mines, Tech. Paper	United States Bureau of Mines, Technical Paper.
U.S. Geol. Surv. Bull.	United States Geological Survey Bulletin.
U.S.P.	United States Patent.
World Petrol.	World Petroleum.
Z. dtsch. geol. Ges.	Zeitschrift der Deutschen Geologischen Gesellschaft.
Z. Geophys.	Zeitschrift für Geophysik.
Z. prakt. Geol.	Zeitschrift zur Praktische Geologie.
Z. ver. dtsch. Chem.	Zeitschrift Vereins deutscher Chemiker.

(Certain periodicals listed above have not been available during 1941).

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Geology and Development.

1.* Falls City Development Heralds Widespread Drilling in Basin. D. Dalrymple. *Oil Gas J.*, 31.10.40, **39** (25), 25.—After many dry holes in the Falls City basin, mainly in Missouri, the Falls City pool was found in Nebraska. A second oil pool has been discovered in Nebraska, an oil and gas pool in Kansas, and three gas pools in Missouri.

The cover of glacial drift has been one of the obstacles to development. Oil and gas have been found in the top of the porous siliceous dolomites of the upper Hunton and in the Misener sand just above. The Viola and the Bartlesville sand are also expected to yield oil.

Oil is obtained from the Hunton at depths of about 2200 ft. in the Falls City pool. There is a dome running north-west to south-east for 4 ml., and it is about 2 ml. wide. In the Shubert area oil comes from the Hunton at 2433 ft. The Mississippian is productive at 1594 ft. in one well at McLouth, Kansas. Showings of oil have been found in the Missouri sector of the basin, but few of the wells have been soundly located from a geological point of view.

A list of the present wildcats is given. There is also a geological column for the basin and a map showing the location of the pools. G. D. H.

2.* Future Oil Possibilities of Newhall-Castiac District. D. Wosk. *Oil Gas J.*, 17.10.40, **39** (23), 24.—The Newhall–Castiac district is one of the most promising in the Los Angeles region. It was productive for some years, and then lay dormant until 1937, when a field was discovered on a small monoclinal fold which is closed by an east-west fault on the south. The wells range up to 7350 ft. in depth, with an initial production of more than 5000 brl. from the Modelo.

In September 1940 a well blew in on the Del Valle anticline 3 ml. to the north-west. It gave 10–15 million cu. ft. of gas/day with 400–500 brl. of oil, from the Modelo at 6653–6900 ft.

The oil history of this region dates from 1856, and for many years oil was obtained from the upturned edges of the Modelo, from which there were many seepages. Drilling was chiefly near the crest of complex, steeply folded, and faulted structures. There were numerous small long-lived fields.

The beds in this area are of Miocene and younger age, with the marine Modelo giving the chief production, any of its sand bodies being potential oil producers. Lenses are probably of importance with regard to accumulation.

The 9-ml. Pico anticline is the main feature favourable to oil accumulation south of the Santa Clara river. Along the axis the beds are steep, but flatten rapidly on the flanks. Wells have had oil showings. G. D. H.

3.* Increased Drilling Activity is Seen for Mid-Continent. W. V. Howard. *Oil Gas J.*, 14.11.40, **39** (27), 57.—For the first ten months of 1940 drilling is running 15% above that for the corresponding period of 1939. Drilling in Kansas and north Texas has increased materially in view of the decline in the Illinois production.

Nearly two-thirds of the increase in drilling activity has been in Appalachian fields. In Ohio there has been a keen search for gas. A new deep sand-play is developing in eastern Kentucky. Drilling has fallen in Michigan, although new fields have been opened in Allegan, Arenac, and Gladwin counties. Encouraging showings have been noted in the Thumb district. Indiana activity has increased by 30%. In Illinois, Salem, Louden, and Centralia are practically drilled up, and there have been no comparable discoveries for two years. The Forest City basin is still mainly one of random wildcatting. In Kansas the new fields at 3000–4000 ft. are shallower than most recent discoveries.

In Oklahoma the Seminole district is still active with a number of extensions and discoveries. Oklahoma's most recent major discoveries are along the Nemaha Ridge. Activity in Arkansas has fallen off by 25% in 1940. North Louisiana has a 25% rise, due to developments at Olla. Many wildcats have been drilled in Mississippi, with disappointing results on the whole. However, some have had encouraging shows of oil. On the Gulf Coast of Louisiana many fields have been found in 1940, old ones extended, and deeper sands developed, but drilling on the Texas Gulf Coast is below

the 1939 level. Texas Panhandle's drilling is 50% above the 1939 figure, and the Rocky Mountain drilling, too, is above the 1939 level.

In 1940 there have been few discoveries in California. Declining production in the Los Angeles basin will encourage wildcatting, especially as a number of tests have been successful, as at Athens, Inglewood, and East Coyote. G. D. H.

4.* **Finding of Deeper Pay Revives Iowa Field in South Louisiana.** N. Williams. *Oil Gas J.*, 14.11.40, **39** (27), 82.—After being almost inactive for several years, new wells are being drilled and old ones deepened in the Iowa field. Formerly the deepest and main producing horizon was the 6900–7000 ft. Marginula sand, discovered in 1931. Recently a new horizon was found in the Lower Frio, just below 8200 ft. This sand is probably more than 40 ft. thick. It gave 633 brl. of oil in 24 hr. on a ½-in. by 6-in. positive choke. The casing pressure was 1750 lb./in.², and the G.O.R. 737. The gravity of the oil is 36·2° A.P.I.

The 6900–7000 ft. sand is nearing exhaustion, and water has encroached, so that only 16 out of 49 wells are in production. Some of the watered wells have been plugged back to produce from shallower sands. About 35,000,000 brl. of oil have been obtained from the 6900–7000 ft. sand, chiefly under natural flow. The sand has an active water-drive, and water encroachment has been gradual and almost uniform. The field is domal, and is thought to overlie a deep-seated salt dome.

The main shallower sands are at 4400–4500 ft., 5000–5200 ft., 5500 ft., and 6600–6700 ft., and they also have active water-drives. Except for the 6600–6700-ft. sand they are all in the Miocene.

The new deep sand seems as though it may be the most prolific, for it is thicker and may be more extensive than the shallower sands. G. D. H.

5.* **New Pool in Prospect in Gallatin County, Illinois.** W. F. Hoover. *Oil Gas J.*, 14.11.40, **39** (27), 87.—In July 1939 a small well was brought in in the Cypress at 2421–2462 ft., after being drilled to the Fredonia and plugged back. Other wells were drilled in this area, but, with the exception of one which gave 175 brl. in six months, all were dry. In September 1940 a 200–300-brl. well was completed in the Rosiclare member of the Ste. Genevieve, and is believed to point to the existence of an oil-pool. Data are given regarding the wells drilled in the area.

The structure is probably pre-Chester, with about 50 ft. of closure. There may be a north-east–south-west fault downthrown to the north-west.

The potential productive acreage is 600–800 acres. G. D. H.

6.* **Claim Panhandle and Hugoton Gas Reserves Ample to Supply Wisconsin Markets.** Anon. *Oil Gas J.*, 14.10.40, **39** (27), 88.—The gas reserves at Hugoton, Kansas, are estimated at 18,000,000,000,000 cu. ft., with the present annual withdrawals about 30,000,000,000 cu. ft. The Hugoton field covers 2,980,000 acres, and there are 330 wells averaging 2800 ft. in depth. The reservoir pressure is 409–430 lb./in.²

The Panhandle field is said to cover 1,475,000 acres and to have 22,195,000,000,000 cu. ft. This field has 1652 gas wells of an average depth of 3000 ft. The present reservoir pressure is about 340 lb./in.² G. D. H.

7.* **Well Logs and Field Data of Active Oil Areas—South Central Oklahoma.** Anon. *Oil Gas J.*, 14.11.40, **39** (27), 122.—The main development began in 1913 with the discovery of the Healdton field. There oil is in Upper Pennsylvanian and Ordovician sands and limes. More than a score of fields have been developed in the west of Carter County. Madill gave some oil from the Trinity (Cretaceous).

Structurally the area is very complicated, with steep dips. The trends were mainly determined in pre-Pennsylvanian times, and the Pennsylvanian is highly irregular. Oil is mainly in irregular Pennsylvanian sands and the Viola and Simpson of the Ordovician. G. D. H.

8.* **California Dry Gas Reserves.** L. P. Stockman. *Oil Gas J.*, 14.11.40, **39** (27), 253.—Although dry gas fields are not yet of economic importance in California, they are likely to be so in the future. Dry gas is produced at the McDonald Island field,

San Joaquin Co., and the Buttonwillow field, Kern Co. The dry gas reserve is of the order of a million million cubic feet.

The largest gas producer in the state is the Kettleman North Dome field, and even now it gives 40% of California's total gas output. The Rio Vista dry-gas field will probably yield 750,000,000,000 cu. ft. It is on an anticline which was discovered geophysically, and some 15,000 acres are said to be proved. The anticline trends N. 50° W., and its closure is apparently less than 50 ft. The Tulare is met at 4045 ft., and consists of sands, sandy clays, silts, and claystones. From 4045 to 5050 ft. are the San Joaquin clays; 5505–9200 ft. Etchegoin sands and Jacalitos; 9200–10,000 ft. Upper Miocene hard shales. The Miocene sand zone is at 10,000–11,000 ft. Some of the sands are oil-saturated, but failed to give production.

The Delano gas field is a dome discovered geophysically, with production in the top of the San Joaquin clay series. There are two zones ranging from 25 to 100 ft. in thickness. The productive capacity is 35,000,000 cu. ft./day.

The gas of the Chowchilla field contains 56% of nitrogen. In the Willows area a well was brought in with a production of 5,356,000 cu. ft./day. Commercial gas has been found 14 ml. west of Marysville, production being from the Cretaceous at 5855 ft.

California's gas-fields are listed, together with the relevant data. G. D. H.

Geophysics.

9.* Prospecting Principles. E. E. Rosaire. *International Oil*, July 1940.—Although prospecting has naturally always formed an integral part of petroleum industry, it is only recently that it has assumed a place comparable in importance with other branches, such as marketing, refining, transportation, and production. The author of this paper traces the development of prospecting and notes three "revolutionary" advances which have been made, the term "revolutionary" being used in a military sense to describe events which have drastically changed not only the conduct of a particular campaign, but equally the whole course of history.

Firstly there was the incidence of geological prospecting from which was evolved the anticlinal theory, forming a platform for all structural prospecting during the last 25 years. Next came geophysical prospecting, which enabled the prospector to explore below the surface of the earth by means other than the drill. Finally a new science of prospecting made its début, the principles of which are based on recognition and measurement of geochemical manifestations of petroleum accumulations, the trap within which such deposits occur being of secondary importance to the actual petroleum itself. In other words, structure, according to this technique of geochemical prospecting, is no longer regarded as a sufficient condition for petroleum accumulation.

The question is then asked as to how modern prospectors should proceed. Are there no basic principles recognized as characteristic of successful experiences? There is no doubt that there are, but unfortunately available evidence seems scarcely favourable to their easy understanding. The author has therefore endeavoured to deduce the fundamentals of prospecting by appeal to a broader field of endeavour, and has accentuated the principles of prospecting by analogy with the principles of war.

The United States army field regulations recognize nine principles of war as follows:

(1) The principle of the objective.
(2) The principle of the offensive.
(3) The principle of mass.
(4) The principle of economy of force.
(5) The principle of movement.
(6) The principle of surprise.
(7) The principle of security.
(8) The principle of simplicity.
(9) The principle of co-operation.

Although certain adjustments in viewpoint are necessary in order to translate these principles of war into principles of prospecting, it is possible to apply them to petroleum exploration. Thus the author suggests that the prospecting chief of staff,

his superiors and his subordinates might well discard rule-of-thumb methods in favour of definite principles of prospection such as he has outlined. H. B. M.

10.* Geochemistry in Prospecting for Petroleum. E. E. Rosaire. *International Oil*, July 1940.—The author of this paper accentuates the importance of recognizing a petroleum accumulation as a dynamic entity rather than a static condition. Visualized thus, it is not difficult to trace the origin of significant hydrocarbons, such as ethane, propane, and butane, in near-surface soil. Even though the actual petroleum deposit is buried under tons of water-logged sediments, proximate rock pressures and concentration gradients are continuously forcing component hydrocarbons into and through its sedimentary environment.

Such continuous leakage over a protracted period results in chemical and physico-chemical modifications of the surrounding and overlying sediments. The essence of geochemical prospecting lies firstly in detecting these manifestations of a petroleum accumulation, and secondly in their proper interpretation.

As a rule structural evidences of petroleum accumulation manifest themselves over or around the centre of the deposit. In the case of geochemical manifestations, however, these reach their maximum intensity around the edges of the petroleum accumulation. In other words, significant hydrocarbons which have escaped into surrounding or overlying sediments in the manner described form a halo or annular pattern in the soil. Thus it follows that soil analysis for the significant saturated hydrocarbons and detection of the halo is destined to play a vital part in geochemical prospecting technique.

Examples of the successful application of this method of petroleum exploration are already to hand. The importance of these achievements, however, lies not so much in the actual discoveries made, but in the knowledge that petroleum accumulations in stratigraphic traps are potentially capable of discovery by means other than the drill.

There is another aspect of geochemical prospecting which may have far-reaching results, and that is geochemical well-logging. Its successful application has already prevented the abandonment of wells as "dry" on the grounds that contract depth had been reached and none of the usual indications of petroleum possibilities were present. The geochemical well-log should, therefore, be carefully assessed before any decision is taken to abandon a hole. If it is favourable, it is more than likely that drilling to a greater depth will transform what appears on other evidences to be a "dry" well into a discovery well. H. B. M.

Drilling.

11.* Oil-Base Drilling Mud. Anon. *Petrol. World*, October 1940, **37** (10), 18.—In developing an oil-base mud it was found that, if properly proportioned, the following materials made a suitable rotary drilling fluid: (1) stove oil, to act as the liquid medium; (2) oyster shells, limestone, or barytes, to serve as weighting materials, and also to impart the initial plastering properties; (3) lamp-black, to give gel strength and structure; (4) blown asphalt, to impart the final plastering properties.

The proportions normally used are 1 part blown asphalt mixed with 1½–2 parts of oil (by weight).

Normally oil-base muds require very little attention while in use in a well. The occasional small adjustments required can be effected by the addition of the proper materials. However, if any major adjustments are necessary, care should be taken to preserve or re-establish the proper inter-relationship between the ingredients.

Precautions should be taken to prevent contamination of the mud with water or water-base mud. Small quantities of water or clay do not affect the physical properties; however, when large quantities of water (+ 15%) are present, the quality of the mud is apt to be seriously impaired.

When oil-base muds are subjected to temperatures above 200° F. for a period of 4 or 5 hrs. their physical properties are damaged. At present neither the reason nor the cure for this condition is known.

Oil-base muds have very little tendency to gas cut; consequently it is permissible

to maintain higher viscosities in the muds, to minimize the chances of settling in the bottom of the well when circulation is suspended. A. H. N.

12*. Chemicals for Treatment of Drilling Mud. C. F. Bonnet and B. N. Howell. *Petrol. World*, October 1940, **37** (10), 67.—Complex phosphates and tannic-acid compounds (tannin extracts) are widely and effectively used for controlling viscosity, gel strength, and water loss in drilling muds. By employing these chemicals low-cost fresh clays, hole-made muds, and muds contaminated in use can be improved and the drilling mud kept in good condition while wells are being drilled.

Complex phosphates quickly reduce viscosity and gel strength and lower water loss to a certain extent.

Tannin extracts reduce water loss and improve the quality of mud cake, sometimes reducing viscosity.

Sodium silicate reduces gel strength and under certain conditions lowers viscosity and water loss.

Sodium bicarbonate restores cement-cut mud.

Excessive treatment or repeated treatment with the same chemical for long periods is harmful. New testing methods make it possible to anticipate over-treatment and avoid difficulties.

While the characteristics of chemicals used in drilling mud are known, the mud is continually changing during use. For this reason frequent tests should be made to guide the treatment, and chemicals should be added on the recommendation of engineers familiar with drilling muds and chemicals.

The paper discusses the properties and uses of the chemicals themselves, and not the way these chemicals are actually used to meet field conditions. A. H. N.

13*. Advancements in California Drilling Practices in 1940. A. H. Bell. *Oil Gas J.*, 24.10.40, **39** (24), 30–32. *Presented before Petroleum division of American Institute of Mining and Metallurgical Engineers.*—Since the discovery of the extremely deep fields in the San Joaquin valley there has been a definite trend towards the development of large and heavy equipment to drill to deepest levels at high speed. This development reached its peak during the past year with the introduction of the 500-lb. steam-pressure superdrilling rig.

The development of extra-heavy drilling equipment for great depths has naturally been followed by higher depreciation costs on this more expensive equipment, and the operators have been forced to drill at greater speeds, even against the handicaps of greater depths, in order to reduce overall drilling costs.

The greatest saving in the slim-hole programme is through reduced size of casing, the water-string usually being 5 in. in diameter. One operator is experimenting with the use of 4½-in. o.d. tubing for drill-pipe and then cementing the tubing in for casing, thus doing away with drill-pipe investment and maintenance. The requirement of the California State Division of Oil and Gas for protection strings cemented over upper oil zones offers some difficulty in planning reduced well costs. Many operators have lately been seeking modification of these rules, claiming that cementing and mudding practices have been greatly improved since the rules were laid down in earlier years, and that the upper zones can now be effectively protected by mudding and cementing behind one water-string.

Cementing practices, mud control, and weight indicator design are briefly discussed. A. H. N.

14*. Unusual Two-Zone Completion Method Used in South Texas. E. C. Will. *Oil Gas J.*, 24.10.40, **39** (24), 35–36.—The usual method of completing a well in two sands is to set a tubing-to-casing packer between the two producing horizons and allow the lower sand to produce through the tubing and the upper sand to produce through the annular space between the casing and tubing. This method, however, was not always practical, for reasons which were discussed in detail. This method has also the great disadvantage of inability to start production from the upper sand flowing again should it cease. Production from the lower sand can always be maintained through the tubing by pumping, swabbing, or any of the other usual methods. However, it is impossible to swab, pump, or otherwise agitate the fluid in the annular space between the tubing and casing.

A new method is described, which incorporates a special patented bottom-hole valve. Two wells have been completed in this manner to date, and a third is now in process. The two completed wells have been producing without trouble for some 2½ months, and it is thought that this method shows considerable promise not only in solving problems of a similar nature in other areas, but also in solving difficulties which at first glance appear to be entirely unrelated. For example, with this device it will be possible to pump a well from two separate sands selectively. Also, in fields where gas lift is practicable, this device may be employed to great advantage in producing from two separate sands at will, by injecting gas through the tubing-string.

A. H. N.

15*. Effects of Different Properties of Rotary Drilling Fluids. H. F. Simons. *Oil Gas J.*, 31.10.40, **39** (25), 46–47.—The principal features of the mud which demand the attention of the engineers, superintendents, and drillers are: (1) weight; (2) viscosity; (3) gel strength; (4) water loss; (5) wall-building properties; (6) thixotropy; (7) acidity or alkalinity, and (8) salinity. In this paper only the first two properties in the list are studied.

A factor not to be overlooked in the study of mud weight necessary to prevent blowouts is that the hole must be kept full of fluid if the pressure is to be maintained. As the drill-pipe is withdrawn, the fluid in the hole recedes, and unless the hole is kept filled, the point may be reached where the formation pressure exceeds the fluid pressure; the results are the same as occur with failure to use a sufficiently heavy mud. Air or gas in the mud will lighten it, and gas-cut mud will sometimes have a specific gravity less than 1, due to the expansion of the entrained gas as it rises to the surface and the pressure is reduced.

By increasing the viscosity, the flow of the fluid may be changed from the turbulent to the plastic type, and the efficiency with which the cuttings are removed is affected accordingly. Some consider that the flow of the fluid in a drilling well is of the plastic type, whilst others think it approaches the turbulent type, due to the velocity of the fluid, the effect of the motion of the drill-pipe, and the slippage of the cuttings.

For viscous flow the slippage of the cuttings is computed by the formulæ: $v = 1{\cdot}789d^2(f - f_2)$ for round cuttings and $v = 0{\cdot}696d^2(f_1 - f_2)$ for flat cuttings.

For turbulent flow the equations for slippage are: $v = 9\dfrac{d(f_1 - f_2)}{f_2}$ for round cuttings and $v = 3{\cdot}5\dfrac{d(f_1 - f_2)}{f_2}$ for flat cuttings, where v = slip in ft./sec.; d = diameter of round or major diameter of flat cuttings; f_1 = density of cutting in lb./cu. ft.; f_2 = density of mud in lb./cu. ft.

A. H. N.

16*. Continuous Logging at Rotary Drilling Wells. J. T. Hayward. *Oil Gas J.*, 14.11.40, **39** (27), 100. *Paper presented before American Petroleum Institute.*—The author discusses the development of procedure and equipment now being used successfully in detecting relatively small quantities of oil, water, and gas brought to the surface from the bottom of a drilling well by mud-circulating fluid used in rotary drilling, together with the method used in determining the depths of the horizons where the samples entered the well-bore.

He describes in detail a number of instruments that have been placed on a panel and installed in a trailer; the trailer is moved from location to location as the drilling rig is moved. Most of these instruments are concerned with the logging of the well as drilling progresses. With these new instruments and methods it is now possible to drill ahead continuously, and to know fairly accurately the type of formation that is being drilled through—its oil, water, and gas contents, and its depth. Information of this nature, obtainable while drilling, is not only helpful in determining completion procedures, but may also become useful in the later life of the well in producing or reconditioning operations.

The trailers and service have now been commercially available a little more than a year, and have been used on approximately 200 wells. In addition to logging, the trailers are at present equipped for routine drilling-mud control and for core analysis. The development is in the early stages, and it is expected that other functions con-

nected with the logging and operations of drilling wells will be added as time goes on. A. H. N.

17.* Hydraulics of Mud-circulating Systems. W. W. Moore. *Oil Gas J.*, 14.11.40, **39** (27), 208. *Paper presented before American Petroleum Institute.*—This discussion does not relate to mud control nor mud conditioning, about which much has already been published. It deals rather with a preliminary analysis of the problem of circulating an average rotary-drilling mud down to and back up from the bottom of the well-bore in such volume and at such velocity as effectively to remove drill cuttings from the face of the formation being contacted by the drill bit and to transport such cuttings up to the surface, where they can be deposited.

The useful work accomplished by the circulating mud stream is normally very small in relation to the energy expended. Much of the hydraulic energy furnished by the slush pump is consumed by friction head within the drill-pipe; whereas no useful work is accomplished by the mud stream until after it has left the drill-bit. In most instances the overall mechanical efficiency of the mud-circulating system can be improved by closer attention to the relationship of hole diameter, drill-pipe size, and slush-pump capacity. Included with this paper are charts and tables which it is believed may assist in analysing the problem introduced here.

It is concluded that: (1) Results in practice, so far as they have been observed, seem to confirm the theoretical advantage of keeping the ratio of drill-pipe size to hole diameter as high as possible, while retaining adequate clearance for fishing operations. (2) Drilling costs are influenced to some extent by the size, weight, and initial cost of the drilling equipment required for a specific operation. More efficient use of slush-pump capacity, therefore, should result in lowered drilling costs. (3) The subject, here discussed qualitatively, would seem to be of sufficient importance to warrant further and more scientific study, so that a quantitative analysis of the various factors involved could be made available to the industry. A. H. N.

18.* Errors in Acid-Bottle Readings. G. H. Scott. *J. Inst. Petrol.*, 1940, **26** (201), 349–356.—A chart of correction, based on experimental data, is given by means of which acid-bottle readings may be corrected to give values accurate enough for all practical purposes. A. H. N.

19. Patents on Drilling. J. C. Curtis. U.S.P. 2,217,674, 15.10.40. Appl. 5.5.38. Portable drill-rig on a wheel-supported carriage.

D. Scaramucci. U.S.P. 2,217,708, 15.10.40. Appl. 8.5.39. Well-cementing method and apparatus which includes as a step the introduction of an exothermic substance ahead of the cement.

R. K. Henderson. U.S.P. 2,217,747, 15.10.40. Appl. 9.6.39. Drillable packer.

J. M. Pearson. U.S.P. 2,217,768, 15.10.40. Appl. 5.11.37. Apparatus for orienting cores by a suspended magnetic system.

R. W. Lyon. U.S.P. 2,217,803, 15.10.40. Appl. 18.11.39. Swivel for drilling oil wells with lubricated inner and outer sets of discs for supporting the hollow stem.

H. T. Byck. U.S.P. 2,217,857, 15.10.40. Appl. 17.4.37. Process for the removal of mud-sheaths by means of an electrode, insulated from the well and maintaining a high positive potential with regard to the mud-sheath.

M. B. Willey. U.S.P. 2,217,879, 15.10.40. Appl. 16.1.40. Method and apparatus for drilling into water-covered ground using submersible barge and foundation, which are later removed to new locations.

C. E. Carpenter and R. C. Lynch. U.S.P. 2,217,889, 15.10.40. Appl. 20.10.38. Diamond drill-bit with a concave working face and a water-way.

P. V. Campen. U.S.P. 2,217,926, 15.10.40. Appl. 23.8.37. Non-aqueous drilling mud with a peptizing agent consisting of an organic nitrogen base.

P. V. Campen. U.S.P. 2,217,927, 15.10.40. Appl. 23.8.37. Non-aqueous drilling mud containing a substance which is soluble in the oil-base and having a sulphur-containing acid radical.

A. J. Penick and K. T. Penick. U.S.P. 2,218,093, 15.10.40. Appl. 9.12.37. Blow-out preventer with a movable ram.

W. W. Gipson, F. N. Fossati, and R. H. Long. U.S.P. 2,218,131, 15.10.40. Appl. 10.2.39. Fishing-tool for wells using a low-voltage transformer to make a flash weld with a metallic object.

P. M. Rea. U.S.P. 2,218,267, 15.10.40. Appl. 31.7.39. Fishing-tool of the overshot type.

K. Nishio. U.S.P. 2,218,295, 15.10.40. Appl. 7.11.38. Apparatus for obtaining core from rotary core-boring.

L. V. Mallory. U.S.P. 2,218,337, 15.10.40. Appl. 8.11.37. Apparatus for recovering implements from wells.

H. W. Ball. U.S.P. 2,218,412, 15.10.40. Appl. 3.10.38. Sheave-block having antifriction bearings.

B. S. Minor. U.S.P. 2,218,473, 15.10.40. Appl. 18.11.39. Swivel with lubricated supporting members.

J. G. Phillips. U.S.P. 2,218,496, 15.10.40. Appl. 16.1.39. Take-off tool for wells.

E. E. Huebotter. U.S.P. 2,218,533, 22.10.40. Appl. 6.2.39. Method and apparatus for filtering and dehydrating drilling mud.

H. L. Strader. U.S.P. 2,218,728, 22.10.40. Appl. 5.4.40. Cementing hook with a flexible cement-conducting member connecting hook and casing-head closure.

D. L. Butler. U.S.P. 2,218,742, 22.10.40. Appl. 22.3.38. Cathead construction.

A. C. Catland. U.S.P. 2,218,743, 22.10.40. Appl. 23.4.37. Well-reamer comprising a cutter on a pin and ball bearings.

L. P. Parker. U.S.P. 2,218,766, 22.10.40. Appl. 22.6.40. Pipe-cutting tool the knives of which are actuated by a piston which is responsive to mud pressure after a valve is closed.

A. D. Maclachlan. U.S.P. 2,219,047, 22.10.40. Appl. 12.1.39. Hose and coupling structure.

D. Miller. U.S.P. 2,219,110, 22.10.40. Appl. 15.8.38. Mast for drilling oil wells and the like.

G. W. Bowen. U.S.P. 2,219,148, 22.10.40. Appl. 3.1.39. Inside pipe-cutter with a hydraulic control for the downward movement of tool and feed of the cutter to the work.

F. N. Osman. U.S.P. 2,219,151, 22.10.40. Appl. 17.3.38. Cable-socket using a soft moulded metal around cable.

P. Hirsch. U.S.P. 2,219,266, 22.10.40. Appl. 9.11.39. Hose- and pipe-coupling consisting of a screw-connected socket and nipple engaging the end of the hose.

O. N. Maness. U.S.P. 2,219,325, 29.10.40. Appl. 9.1.39. Method of cementing wells, the seal being outside a perforated liner and using a non-penetrating liquid to drive the sealing liquid through the liner.

E. Wiemer. U.S.P. 2,219,435, 29.10.40. Appl. 28.8.37. Process and device for treating muds.

A. T. Cooper and L. F. Valentine. U.S.P. 2,219,512, 29.10.40. Appl. 21.3.38. Device for surveying drilled holes by means of a plumb-bob and compass which are locked to show their position inside the well-bore.

W. Wright. U.S.P. 2,219,880, 29.10.40. Appl. 10.8.38. **Pipe-clamp.**

D. V. Waters. U.S.P. 2,220,983, 12.11.40. Appl. 3.6.39. **Apparatus for power-flow control utilizing two power-supply members, one at constant speed, driving a differential gearing system.**

L. F. Brauer. U.S.P. 2,220,989, 12.11.40. Appl. 14.4.39. **Well clean-out bailer with a special type of valve at bottom to allow variation in size of debris which can be forced through an aperture by fluid pressure.**

J. H. Wilson. U.S.P. 2,221,067, 12.11.40. Appl. 19.2.38. **Structural steel derrick which is made of two halves, which are raised by means of a central mast.**

J. J. Santiago. U.S.P. 2,221,204, 12.11.40. Appl. 25.4.38. **Cementing plug adapted to be lowered on a suspension pipe and to deliver fluid from the pipe either below or above the packer.**

D. McClelland. U.S.P. 2,221,242, 12.11.40. Appl. 28.1.39. **Drill.**

M. C. Nesbitt. U.S.P. 2,221,359, 12.11.40. Appl. 23.6.37. **Hoist with two drums and special differential gearing which allows both drums to be used simultaneously from one source of power.**

J. C. Fortune and W. R. Walne. U.S.P. 2,221,376, 12.11.40. Appl. 6.6.38. **Rotary drilling equipment using a round flush-joint grief stem and slips to hold it firmly.**

C. F. Baker. U.S.P. 2,221,392, 12.11.40. Appl. 14.12.38. **Core-catcher.**

A. R. Maier. U.S.P. 2,221,486, 12.11.40. Appl. 29.12.38. **Guard for rotary machines.** A. H. N.

Production.

20.* Pressure Maintenance. O. W. Willcox. *World Petrol.*, October 1940, **11** (10), 36–41.—The history and significance of pressure maintenance projects are reviewed. "Critical phenomena" and retrograde condensation and distillation and their importance in high-pressure pools are studied with particular emphasis on the gains to be expected from pressure maintenance in such areas. As an example the following case is cited :—

Studies of the history of the Kettleman field in California and Oklahoma City have resulted in the conclusion that these large petroleum deposits were originally under pressure and temperature such that a considerable proportion of their contents were in the sub-critical gaseous state; that is, they were combination oil and distillate pools, with an upper gas-zone above a liquid oil-zone. It is said that if the pressure on these two fields had been maintained by cycling, vast amounts of natural gasoline, and even motor fuel, might have been obtained. But in those days the operators of those fields knew nothing about critical states and recycling operations; the only use they had for a compressor was to pump what dry gas they could to consuming centres; the rest could be thrown away. The consequence was that their formation pressures declined to a point where the valuable light hydrocarbons came out of the sub-critical state (retrograde condensation) and mingled with the general fluid contents of the pools. Superficially considered, this might not be supposed to represent a loss, as the liquid may still be subject to recovery by pumping or by an eventual repressuring. However, a hydrocarbon that exists in the sand in the sub-critical state is mobile and is 90% or more recoverable by rational pressure maintenance. On the other hand, even under the very best conditions scarcely 50% or 40% of the liquid contents of an oil reservoir are recoverable by any generally available means; the rest wets the sand grains and sticks. A. H. N.

21.* Modern Well Studies. Part 3. F. Briggs. *Oil Wkly*, 21.10.40, **99** (7), 29.—Dynamometer cards obtained on the polished rod of a pumping well reflect loads composed of many factors, and for that reason are to a certain extent unpredictable. The loads set up in a sucker-rod string during the pumping motion are the ultimate

combined results of (1) the weight of the rods, (2) the force required to accelerate the rods, (3) the weight of the oil, (4) the force required to accelerate the oil on the upstroke, (5) friction of the rod-string, (6) friction in the stuffing-box, (7) friction resulting from the motion of the plunger, (8) friction of the oil in the tubing, (9) a friction loss through the valves, and (10) stress waves and reflections contained within the rod-string which are created by any of the above impressed forces. These factors are not always taken into consideration; nor is it necessary to understand their significance and implications in normal dynamometer studies.

Vibration effects are studied in some detail. Sometimes vibrations in rod-strings are desirable, at other times they are of no consequence, and at still others they are troublesome and not wanted.

Well-pound is explained and illustrated in great detail. Over-travel and under-travel causes and effects are further studied and illustrated, and wells of the agitators, semi-agitators, and true pumpers are typified. An analogy to the electrical-power-factor term has been offered to describe the power or work of a pumping well. The term "mechanical power factor" may be aptly applied to this phase of a pumping well. In electrical terminology, power is said to be the result of the voltage multiplied by the amperes times the cosine of the phase angle of lag or lead of the two previous terms. In other words, power is equal to $EI \cos \theta$. Similar to this, the mechanical power factor may be the force times the velocity times the cosine of angle of lag between these two factors. It has been said that "if the force and velocity are cyclic in nature, they can be resolved into harmonic components. If these components are in phase, it is obvious, for a given power requirement and a given velocity, the force will be a minimum. If they are out of phase, the force must necessarily be larger to give the same power."

The paper is generously illustrated by many cards and graphs. However, the promise given of deriving Rieniet's equation in Part 3 does not materialize, although many of the variables considered in the formula are studied. (See Abstract No. 1557, 1940.)

A. H. N.

22.* **Subsurface Waters Gaining Favour for Flooding.** Anon. *Oil Wkly*, 21.10.40, **99** (7), 22–26.—The problem of water for flood projects differs in some important respects from demand for other oil-field operation. Once a project is started, the water supply must be available and sufficient to carry on the flood without interruption. Volumes may vary from 100 to 50,000 brls. daily. It must be free of matter that might clog the pores of the sand. It must not chemically react with formation water or strata compounds to precipitate a floc. In many respects the water must be more nearly pure than ordinary city waters. The treated supply must not corrode equipment unduly, nor must the over-all water-control cost be above a few cents at the input well.

Use of any type of surface supply leaves much to be desired. There is always the question of shortage during seasons of minimum rainfall. Flood stages are doubly bad; first, because there is danger of the dam breaking, second, because flood-waters increase dirt and silt content. Combined with these drawbacks is the necessity of changing the treatment to counteract the changes in the make-up water.

Lime strata as a water-source are then discussed in detail in so far as they fulfil the requirements of flooding from all these viewpoints. Treatment of the lime-water to render it safe and economical to use is detailed step by step, and the chemical reactions are explained where necessary.

It is concluded that the successful use of lime-water has provided the flood operations with a wider scope than has been possible hitherto. Some possible areas, previously condemned for immediate development through lack of surface-waters or uneconomic pipe-line distances, may now be developed, with the water being obtained from lime horizons at no increase in the per-barrel cost of the injected water.

A. H. N.

23.* **Modern Well Studies. Part 4.** F. Briggs. *Oil Wkly*, 28.10.40, **99** (8), 26.—This part forms the conclusion of the series of papers on well studies, and deals with the use of the well studies in counterbalancing wells.

Counterbalancing a single well is studied first. No study is made of the counter-

balancing systems; only the magnitude and direction of the counterbalance are determined. The methods of slipping the clutch, using a tachometer, and of electric-power measurements are briefly discussed, and dynamometer card studies for counter-balance are dealt with in more detail. Typical third- and second-order cards are shown for good, over-, and under-counterbalance conditions. Changes effected in the shapes of the cards by improving the counterbalance in various typical cases are illustrated and the significance of such changes is discussed.

Finally, central-power counterbalancing is analysed. First, the procedure is given, which may be summarized as follows: Dynamometer cards are obtained on each of the rod-lines near the central power. The rod-lines are identified with the eccentric on which they work and the direction from which they leave the central power. The dynamometer cards are transferred to polar diagrams. The loads on the various rod-lines are determined from the dynamometer cards for each 30° interval of crank rotation. Vector diagrams of these forces or loads are drawn for each 30° interval of crank rotation. Resultants of each of these forces diagrams are resolved into the right angle and parallel component with respect to the crank position. Using the right-angle component, diagrams are drawn plotting these components against the angle of crank rotation. The horizontal components are then plotted against the angle of crank rotation. These resulting diagrams show the condition of the power with respect to torque and overturning force, from which weight changes can be made to give better operations.

Second, this procedure is illustrated by working out an example in complete detail, the example being an actual case of a central power for eleven wells operated from two eccentrics centred on one power-wheel, the eccentrics being one below, and 180° out of phase of the other.

[Cf. Abstracts Nos. 1557, 1559, (1940); and **21** (1941).] A. H. N.

24.* Pressure Project Involves 150 Individual Operators. Anon. *Oil Wkly*, 28.10.40, **99** (8), 19–24.—The largest co-operative pressure maintenance programme in the history of the oil business is being conducted in the K-M-A field of North Texas. This project involves co-operation among nearly 150 individual operators, owning more than 1300 wells and something like 25,000 producing acres.

The chief operating difficulty encountered has been that of hydrates in the gas, which froze connections and instruments at the point of greatest pressure drop between the distribution lines and the input well-head. When the gas was measured back to the leases for the pressure maintenance, it was found to be so "soft" that a great amount of research and investigation was necessary to establish a factor acceptable to those concerned for converting the visible meter readings to actual cubic feet. For the time being, a super-compressibility factor of 1·33 is being used.

To reduce the ice-forming propensity of the gas, most of the gasoline compression plants have facilities for drying. Activated alumina is used in two of the units, and two employ low-temperature refrigeration coupled with diethylene glycol for the removal of water. The plants which employ activated alumina have vessels installed so that they can be operated in units of one or more, and so that units of one or more can be regenerated by passing gas at a temperature between 350° and 400° F. through the material to drive out the absorbed moisture removed from the gas. The plants equipped with low-temperature chilling by expanding propane in specially designed heat-exchangers are the first of their kind to use diethylene glycol in direct contact with the commodity coupled with low-temperature chilling, and have been successful in reducing the dew point of the gas to 0° F., at 1800 lb. pressure. The plants and method of utilizing diethylene glycol are studied in general. A. H. N.

25.* Unusual Testing Methods Used in Texas Recycling Project. G. Weber. *Oil Gas J.*, 31.10.10, **39** (25), 48.—To facilitate control and testing of the distillate-producing wells, all producing wells in a particular field have been equipped with surface connections arranged to permit sampling and flow measurements. The well-head connections include a vertical loop in the line from the christmas tree. Accurate metering of gas is possible in the vertical meter setting, as no weep-holes are required for drainage of liquid through the orifice plate. The orifice meter is equipped with liquid seal-pots, which are kept half filled with condensate during warm weather.

This condensate may be replaced with anti-freeze solution such as ethylene glycol during the winter.

Samples of the well-fluid are obtained from a special connection on the upstream side of the vertical loop. The well-fluid at this point contains some distillate in the liquid phase, so it is necessary to use a special sampling device that will obtain a representative sample of the gas–liquid mixture leaving the well. For this purpose a special sampling tube is welded into the line. A sharp-edged, stream-lined nozzle of small diameter is attached to the lower end of the sampling tube, and is located in the centre of the flow-pipe, with the sharp open edge of the nozzle directed against the direction of fluid flow. A valve and threaded connection on the top of the sample tube permits connection of the sampling to the portable test unit. High-pressure flexible tubing is used for making this connection. Sampling procedure is detailed.

It is emphasized that the test procedure does not affect the producing well in any way. The rate at which the well is producing is not affected, and the back pressure on the well is not changed. Therefore, the well is tested under conditions that are entirely normal, and the question of the possibility of effect of abnormal flow conditions on the distillate content of the well-fluid, that are required in some suggested test procedures, is entirely eliminated. A. H. N.

26.* Application of Core Analyses to Production Methods. J. A. Lewis. *Oil Gas J.*, 31.10.40, **39** (25), 56.—The production of gas, oil, and water from a well takes place only after flow of these fluids through permeable reservoir formations. The analysis of cores has developed to a point where it is possible through accurate and complete analysis of contaminated or uncontaminated cores to predict with a high degree of accuracy the type of fluid production that will result by exposing a given cored interval to a pressure lower than that present in the formation. Having obtained gas or oil production, the problem resolves itself into one of evaluating the formation in terms of rate and ultimate production.

The discussion presupposes that the formation is oil productive and that accepted core-analysis methods were combined with connate water and residual oil saturation data in computations for recovery. These determinations, correlations, and applications in accordance with principles previously published by Muskat and Wyckoff were successfully made and applied in the water-flooding area of Pennsylvania.

It is expected that from a correlation of these formation and fluid characteristics with field operation a sound basis for oil-reservoir development and operation will result. A. H. N.

27.* Economics of Controlling Water Produced with Oil. J. U. Teague. *Oil Gas J.*, 14.11.40, **39** (27), 125. *Paper presented before American Petroleum Institute.*—The economics of doing remedial work to exclude the water from wells producing water and oil is a problem of serious concern to the operator.

The production of water in some fields is no doubt injurious to the oil-producing reservoir, and should be excluded to conserve reservoir energy and increase ultimate recovery. In many other fields there is no apparent damage to the reservoir by the production of water, and any remedial work done must be justified by the saving in operating cost resulting from not having to lift the water and then dispose of it.

The principal factors that should be considered in determining the economics of remedial work are: (1) physical characteristics of the reservoir; (2) effect of water production on reservoir energy and ultimate recovery; (3) means of determining the source of water; (4) types of remedial work in common use; (5) increased operating costs due to production of water with oil; (6) disposal of water produced.

It is important that the statistical data and information necessary to evaluate these factors be accumulated prior to the time the production of water becomes acute and a decision on remedial work must be made. A. H. N.

28.* Oil Recovery by Air-Drive in Venango Fields of Pennsylvania. P. A. Dickey and R. B. Bossler. *Oil Gas J.*, 14.11.40, **39** (27), 161. *Paper presented before American Petroleum Institute.*—The secondary recovery of oil by air-drive for approximately 15 years has been practised generally in the Venango oil-fields of North-western Pennsylvania. Hitherto no attempt has been made to analyse the results and estimate the quantity of oil recoverable by this method.

The production-decline curves of properties on which no new development has take place over a period of several years approximate straight lines on logarithmic pape Following accepted procedure, the economic life and cumulative ultimate oil recover of the properties may thus be predicted. Unfortunately predictions could be made fo only a few of the older properties and for none of the newer developments, because o most leases new work so affected the oil production that no conclusions could b reached. Twelve leases showed suitable curves. The estimates of cumulati ultimate recovery range from 11 to 100 bbl./acre-foot, with an average of 42 bb The economic life ranges from 9 to 48 years, with an average of 28 years.

Whereas a large number of factors affects the recovery of oil by air-drive, it i believed that the principal ones are the original oil and water content of the sand the spacing of the wells, and the efficiency of the application of air to the sand. Th latter factor is seriously affected by the by-passing of air through the more permeabl beds, and is difficult to take into account.

It is suggested that ultimate oil recovery and well spacing are connected by a equation of the type: $Y = ae^{-b \times P}$. Tentative values, based on the available data were assigned to the constants. A. H. N.

29.* Factors Affecting Reservoir Performance. R. D. Wyckoff. *Oil Gas J.*, 14.11.40, **39** (27), 188.—It is pointed out that in attempting to outline concisely the factor affecting reservoir performance and to describe the technique necessary to determin these factors, the author is handicapped by the relatively immature state of develop ment in reservoir technology. Important basic theoretical facts are known, an idealized analyses are possible. What is needed are the qualifying factors obtainabl only from experience, which will permit the application of theory to practice.

The problems encountered are discussed under two main classifications: (1) factor inherent in the reservoir, and over which little or no control is possible; (2) factor influenced by the exploitation programme (*i.e.* under partial or complete control).

The types of reservoirs are studied as affected by structural, pay-zone, and fluid content characteristics. These characteristics belong to the first of the two class fications, and to determine them all possible information should be gathered. A discussion of core analysis and bottom-hole sampling and pressure measurement indicates the methods used to study and interpret these characteristics.

The factors influenced by exploitation programme present even greater complexities because of interdependence of all these factors. The functions of a well are outlined and an analysis of location of wells in the reservoir and of well-diameter effects on production follow conventional lines.

Reservoir mechanics are discussed under water, gas, and combination drives, both natural and artificial. The differences exhibited by reservoirs due to the differen types of drives or controls are outlined in generalities.

The study of well-spacing at the end of this comprehensive paper is of interest, as a discussion is made of the assumptions regarding radii of drainage of wells. It is stated that 10 years' intensive search for some physical phenomena in the pro duction mechanism leading to a limited radius of drainage has failed to disclose its existence—not only in water or gas-cap drives but even in internal gas drives. Thus it is concluded that what really exists is not a physically but an economically limited radius of drainage.

The paper is in the form of a stimulating discussion and is free from dogmas. A. H. N.

30.* Some Notes on Plunger Lift Operation. F. R. Wellings. *J. Inst. Petrol.*, 1940, **26** (195), 19–28.—The paper deals with actual experiences of wells on one field only, but as the wells considered possess such widely differing characteristics, it is thought the general principles so derived may be applicable to other wells. It is concluded that up to the time of writing the disadvantages of two-piece plungers outweigh the advantages. A. H. N.

31. Patents on Production. W. A. Fry. U.S.P. 2,217,676, 15.10.40. Appl. 27.5.37. Treatment of wells having calcareous formations with HCl having a calcium pre cipitating agent soluble in the acid solution.

J. B. Hawley, Jr. U.S.P. 2,217,746, 15.10.40. Appl. 22.2.37. Submersible pump with a shaft and an impeller.

E. V. Hewitt. U.S.P. 2,217,749, 15.10.40. Appl. 26.1.39. Liquid recovery and gas recycle method utilizing two wells simultaneously to produce from two formations having both gaseous and liquid hydrocarbons.

G. S. Knox. U.S.P. 2,217,986, 15.10.40. Appl. 29.4.40. Well-pipe plug adapted to be lowered and set in the well-casing.

J. B. Hawley, Jr. U.S.P. 2,218,003, 15.10.40. Appl. 25.2.37. Submersible pump motor.

A. D. Garrison and C. F. Teichmann. U.S.P. 2,218,025, 15.10.40. Appl. 10.6.38. Method of treating a well by setting a filter pack of a granular oil-wettable, water-repellent material with interstitial spaces of capillary dimensions.

G. W. Rusler and V. V. Vacquier. U.S.P. 2,218,155, 15.10.40. Appl. 17.1.40. Formation tester with a packer and check-valves.

C. M. O'Leary. U.S.P. 2,218,214, 15.10.40. Appl. 18.3.38. Pumping apparatus with balancing arrangement utilizing an incompressible fluid passing from one cylinder into another cushioning cylinder, the latter containing a compressible fluid.

C. M. O'Leary. U.S.P. 2,218,215, 15.10.40. Appl. 17.2.40. Air balance for pumps comprising a balancing cylinder closed at its opposite ends and a reciprocating piston forming upper and lower compression spaces.

C. M. O'Leary. U.S.P. 2,218,216, 15.10.40. Appl. 25.3.40. Fluid counterbalance for pumping apparatus for wells where walking-beams are used.

K. Austerman. U.S.P. 2,218,306, 15.10.40. Appl. 3.6.38. Method of treating oil-wells with an alloy of an alkali metal, the alloy having a specific gravity in excess of 1.

I. J. McCullough. U.S.P. 2,218,802, 22.10.40. Appl. 27.2.39. Gun perforator in which the products of explosion from the firing charge of one chamber is conducted to fire other charges in the succeeding chambers, the products being restrained from being lost.

N. H. Armstrong and R. M. Marr. U.S.P. 2,218,839, 25.10.40. Appl. 5.8.38. Stuffing-box for pumping well-casing.

J. W. Johnson. U.S.P. 2,218,955, 22.10.40. Appl. 24.2.39. Guide for flexible well lines when being lowered through well-casing.

M. O. Johnston and D. B. Chapman. U.S.P. 2,218,988, 22.10.40. Appl. 5.1.39. Adjustable flow-bean consisting of a series of ports in a tubular element, which ports can be successively opened or closed to increase or decrease rate of flow in the tubular element.

I. S. Salnikov. U.S.P. 2,219,022, 22.10.40. Appl. 25.7.39. Method for completing oil-wells in a formation of multiple producing zones whereby the diameter of the casing set in the formation is reduced against the pay-zones, the reduced sections being drilled and reamed off after the cement is set.

M. Jacobs. U.S.P.P. 2,219,161 and 2,219,162, 22.10.40. Appl. 28.11.38 and 21.8.39, respectively. Pipe couplings.

V. A. Hoover. U.S.P. 2,219,318, 29.10.40. Appl. 24.3.38. Motor construction for submersible purposes.

C. R. Irons. U.S.P. 2,219,319, 29.10.40. Appl. 18.5.38. Treatment of wells for sealing a formation by a liquid sealing agent and using a non-penetrating liquid above the sealing liquid to drive the sealing agent into the formation.

R. L. Ralston. U.S.P. 2,219,635, 29.10.40. Appl. 20.4.39. Device for eliminating gas-lock in pumps by means of a by-pass.

J. H. Notley. U.S.P. 2,221,057, 12.11.40. Appl. 18.7.39. Well agitator by means of a chamber which is alternately filled by, and emptied of, the well fluid.

M. Hector. U.S.P. 2,221,137, 12.11.40. Appl. 16.2.40. Safety cleaning-tool having a knife for cleaning deposits from oil-well tubing, pipes, casings, or formation.

P. J. Lehnhard, Jr. U.S.P. 2,221,261, 12.11.40. Appl. 2.5.39. Method of treating wells by forcing fluid into the formation through granular material located in the well, opposite the formation, and using a non-penetrating fluid to force the sealing fluid.

D. A. Limerick. U.S.P. 2,221,353, 12.11.40. Appl. 27.3.39. Process for treating an oil-well to clean it from organic deposits, using an exothermic reaction between acids to melt the deposits.

M. M. Kinley. U.S.P. 2,221,427, 12.11.40. Appl. 29.3.37. Swab, consisting of two swabs and a valve.

J. R. Mahan and J. B. Picard. U.S.P. 2,221,428, 12.11.40. Appl. 29.12.39. Counterbalance device consisting of weights carried on supports which are mounted on a shaft. A. H. N.

Cracking.

32.* Solubility of Cracked Residues in Some Solvents. J. Voskuil. *J. Inst. Petrol.*, 1940, **26** (196), 57–71.—Experiments are reported on the solubility of cracked residues in aliphatic hydrocarbons as well as in *cyclo*hexane. The solubility of these residues in pure benzene is made a special study. The colloid–chemical nature of the cracked residue is demonstrated by comparison of extraction and dilution methods. A. H. N.

Synthetic Products.

33.* Synthesis of Lubricating Oils by Condensation Reactions. Part 1. W. R. Wiggins, T. G. Hunter, and A. W. Nash. *J. Inst. Petrol.*, 1940, **26** (197), 129–145.—The study is that of the condensation of chlorinated paraffin wax with aromatic hydrocarbons, using metallic aluminium as catalyst to give viscous hydrocarbon oils of high viscosity indices and of viscosity–gravity constants comparable to those of paraffin base-oils. A. H. N.

34.* Synthesis of Lubricating Oils by Condensation Reactions. Part 2. W. R. Wiggins, T. G. Hunter, and A. W. Nash. *J. Inst. Petrol.*, 1940, **26** (199), 225–234.—The engine-wear, oil consumption, carbon deposits, and conditions of oil in crank-case were determined for 2 synthetic oils. The oils were condensation products of chlorinated paraffin wax and benzene using metallic aluminium as catalysts in one case, and aluminium chloride in the second. A. H. N.

Refining.

35. Refining Characteristics of Illinois Basin Crude Oils. G. Egloff, G. B. Zimmerman, and J. C. Morrell. *Oil Gas J.*, 26.10.39, **38** (24), 81.—The properties and yields on laboratory fractionation and cracking and qualities of products from Salem, Illinois Pipe Line, Louden, Mount Carmel, and Sandoval crudes from the Illinois basin are given.

Salem crude yields on distillation 35·7% vol. of 400° E.Pt. gasoline of 53·5 O.N. and 25·6% of furnace-oil distillate. Combined topping and cracking increased the yield to 62·7% of 64 O.N. gasoline with 14·3% of No. 2 furnace distillate of pour point — 35° F. and 19·7% of residual fuel of Grade 6 quality with a viscosity of 222 secs. S.F. at 122° F. and a cold test of 45° F. The use of a catalytic polymer plant and an absorption plant would increase the yield of gasoline to 64·9% and its O.N. to 65, the addition of 3 c.c. lead bringing this to 75.

Illinois Pipe-line Crude yields 16% of 250° E.Pt. gasoline of 70 O.N. and 21·3% of naphtha or 37·3% of 400° E.Pt. gasoline of 54 O.N. and 9·7% kerosine. Cracking

the reduced crude gave yields of 41·2–52·3% of gasoline of 68–69·5 O.N. and residues of No. 6 grade quality. Absorption and catalytic polymerization would yield 3·7% of gasoline, increasing the overall O.N. by 1·5.

Louden Crude is similar to Salem Crude, yielding 29·7% of 350° E.Pt. gasoline of 54·5 O.N., 7·0% of naphtha (or 36·7% of 420° E.Pt. gasoline of 49·0 O.N.), 8% kerosine, 10% gas-oil, 18% wax distillate, and 25·5% of bottoms of viscosity 468 S.U. at 210° F. Mount Carmel crude gives 36·2% of 400° E.Pt. gasoline of 55 O.N. and 10% of kerosine, and 53·7% of residue of cold test 40° F. and visc. S.U. at 100° F. of 457 secs. Sandoval crude yields 32·8% of 400° E.Pt. gasoline of 50 O.N. 11·0% kerosine, 26·9% gas-oil of cold test 45° F., and 29·2% of residue of cold test 60° F. and viscosity 199 secs. S.U. at 210° F. C. L. G.

36. Solutizer Process for Sweetening Gasolines. L. E. Border. *Oil Gas J.*, 18.7.40, **39** (10), 36.—Results obtained on a semi-commercial scale solutizer pilot plant, using the potassium salt of *iso*butyric acid dissolved in KOH for the extraction of mercaptans from various gasolines, are discussed. Extraction in a four-stage mixer-settler system and in a packed tower are compared, and two methods of regeneration of the solutizer solution studied. It was found that using the mixer-settler system the mercaptan sulphur (originally 0·05%) in 400° E.Pt. straight-run West Texas gasoline could not be reduced below 0·0017%, whereas in a packed tower a figure of 0·0004% was obtained. Extraction is improved by increasing solutizer concentration, and solutizer/gasoline ratio and reducing temperature, the extent of the effects being shown graphically. Loss of gasoline by solution in the spent solutizer is reduced in practice by diluting the latter with water, the gasoline released being returned to the main stream. The two methods of regeneration examined were: (1) direct injection of steam into the bottom of the stripping column, the overhead being condensed and both phases discarded, the stripped solution being pumped through the base of the tower, through the cooler when it is ready for use, and (2) a system of closed re-boiling in which the overhead aqueous condensate was returned to the top of the column as diluent and subsequently vaporized in the re-boiler to supply the stripping medium.

The first system has the following defects: (*a*) CO_2 from the steam accumulates in the solutizer, (*b*) mercaptans are present in the aqueous condensate and must be removed before discharge, and (*c*) the partial pressure of mercaptans is greater over a dilute caustic solution than over a concentrated solution, thus favouring the use of a dilute solution for the best stripping. The second system, using closed re-boiling, is free from these defects, since the stripping steam is free from CO_2, and the aqueous condensate is returned to the column while the solutizer is diluted before flowing down the column. No advantage was found in maintaining pressure in the regenerator. The adequacy of stripping of the solutizer can be tested by carrying out a doctor test on the solution shaken with mercaptan-free gasoline. Ten trays have been found enough when the closed system is used. Re-boiler tubes of 70·30 Cu·Ni alloy give adequate corrosion resistance, whilst stripped solution cooler tubes of stainless steel are perfectly smooth after 1 year's service, carbon-steel tubes corroding rapidly. The remainder of the system, apart from a slight metal loss in the vapour line, shows little evidence of corrosion.

Treating conditions for various gasolines were studied. The heavier cracked gasolines generally contain alkyl phenols, and are best treated with a "mixed" solutizer consisting of alkaline potassium *iso*butyrate containing alkyl phenols, whilst straight-run and light-cracked gasolines may be treated with the straight solutizer. Tabulated data on O.N. and lead susceptibilities of different types of solutized gasolines indicate that in practically every case the O.N. of the sweet unleaded gasoline was as high as or higher than that of the sour stock, whilst the lead susceptibility is unaltered. C. L. G.

Metering.

37.* Viscosity and its Effect on the Accuracy of Positive Displacement Metering. J. W. Donnell. *Proc. Petrol. Fluid Metering Conf.*, 11.4.40, 13–21.—Viscosity is defined and viscous and turbulent flows are studied. Formulæ are derived for calculating

slippage losses for viscous flow in positive displacement metering, and examples are worked out in detail.

If the quantity of fluid forced through the meter is increased to a certain point, laminar flow through the slippage spaces will change to random fashion or turbulent flow. This point of transition has been found to vary with the following factors: size and shape of passage, density of fluid, velocity of fluid, and viscosity of fluid. These factors grouped together are known as the Reynolds number $Du\rho/\mu$, where D = Diameter in feet or a shape factor equal to four times the mean hydraulic radius; u = velocity in feet/sec.; ρ = density in lb./cu. ft.; and μ = viscosity expressed in lb./ft. sec. It has been found that streamlined flow can exist only when the Reynolds number is below 2100. As an example of this test for streamline flow, an illustration is worked out completely.

The paper is well illustrated. A. H. N.

38.* Fundamental Principles of Volume Meters. E. E. Ambrosius. *Proc. Petrol. Fluid Metering Conf.*, 11.4.40, 22–26.—The principles of designing and operating fluid-meters are studied, and all types of meters are well illustrated by diagrams or photographs. The types of meters treated are classified under weighing, volumetric, and velocity meters. The first two classes are true "Quantity Meters," the distinctive feature of these meters being that all the fluid to be metered passes through the primary element in successive and more or less completely isolated quantities. The velocity meters belong to the rate-meter division through which the fluid flows in a continuous stream. The registration of these meters is derived from the action of the moving stream on the primary element.

The meters described are: (1) weighing or tilting-trap type; (2) volumetric, which include nutating piston, reciprocating piston (or simply piston), planetary piston, sliding or rotating vanes, gear or lobed impeller; (3) velocity meters, including helical and turbine meters. A. H. N.

39.* Some Fundamental Considerations in the Design and Application of Displacement Meters. E. W. Jacobson. *Proc. Petrol. Fluid Metering Conf.*, 11.4.40, 29–33.—In the manufacture and application of displacement meters for measuring liquid hydrocarbons, extravagant claims of precise measurement have often been made. These have led to considerable trouble from failure of the meters to perform as claimed and from failure not only to check measurement by gauge-tanks, but also to check one meter against another. The limit of error most often quoted is 0·1%. This limit of error is examined as to its actual magnitude and the difficulty of obtaining measurement within this limit.

From the consideration of fundamental principles it is concluded that: (1) the claimed standard of measurement has been closer than commercially practical; (2) a close study of the characteristics of the two types of displacement meters—namely, pack and film sealed—indicates particular fields of application for each type, depending on accuracy of measurement required, permissible pressure drop, nature of register load, and range of viscosity of fluids to be metered; (3) the economics governing the installation of displacement meters must consider not only the cost of the meter, but also the additional cost of adequate liquid conditioning equipment, calibrating devices, and regularly scheduled maintenance, if satisfactory meter performance is to be obtained. A. H. N.

40.* Metering of Crude-Oil Production. E. O. Bennett. *Proc. Petrol. Fluid Metering Conf.*, 11.4.40, 34–35.—Meters are precision-built pieces of machinery; and in order to perform with maximum reliability, they must receive proper attention from those familiar with their design and construction. With such attention, meters will precisely measure large volumes of oil with but little maintenance cost, and will save a large amount of money otherwise required for gauge-tanks and equipment.

Some pipe-line operators have meters installed on their systems with electric recording of all measurements in the dispatcher's office at headquarters. Such a system eliminates considerable personnel, and gives direct results at all times.

Meters are being more generally used in the producing industry as time goes on.

It is believed that their use will increase when operators understand and desire to take advantage of field stabilization or controlled evaporation losses of light high-gravity crudes made possible by the use of metering under pressure throughout a recovery plant. A. H. N.

41.* **Calibration of Meters in Pipe-Line Service.** H. Pohl and E. H. Counts. *Proc. Petrol. Fluid Metering Conf.*, 11.4.40, 36–38.—Present knowledge of the use of positive displacement meters shows that they can be used for the measurement of crude oil and other petroleum products in pipe-line service if the counter mechanism is in proper adjustment, and the conditions under which the meter operates have been studied sufficiently, so the proper meter and auxiliary equipment needed for the particular job are used. Calibration of meters from time to time is necessary to correct errors in measurement due to wear, replacement of parts, changes in the physical properties of the oil, and in some cases to changes in operating conditions.

The calibration of meters can be accomplished with varying degrees of accuracy by comparing the volume registered by a meter against volumes shown by a calibrated proving tank, stock, or storage tanks, and against a master meter. Of the three methods, comparing meter readings against a calibrated proving tank is believed to be the most practical and accurate method for calibrating positive displacement meters in pipe-line service. A. H. N.

42.* **Problems Encountered in Distillate Measurement.** E. Kightlinger. *Proc. Petrol. Fluid Metering Conf.*, 11.4.40, 39–41.—In most gas-fields it is impossible to locate the gasoline plant in such a manner that the liquid can be easily transported to the plant without its being carried through the gas-flow lines. Separators are installed at each well with the gas being drawn from the top of the separator and the distillate from a point near the bottom. The gas-flow is constant and measured through a standard orifice meter, while the liquid flow is governed by various type dump valves generally operated intermittently by a float within the separator. After the distillate passes through its meter it is carried through a separate line to a point downstream of the gas-meter, where the gas and liquid are again mixed in the flow-line. Both fluids are carried to the gasoline plant, where the distillate is again separated from the gas before the gas is taken into the plant for processing.

Due to load requirements, it is seldom possible to flow gas-wells at a steady volume for a long period, and at times it may be necessary to flow the wells at a low volume, due to prorated pulls, and thus help cause at least one, and maybe two, undesirable conditions.

The principal sources of trouble might be listed as follows: (1) Low gas differential across the orifice plate. (2) Fluid dump-valves not operating properly. (3) Paraffin. (4) Sand. (5) Water. (6) Hydrates.

These items are studied separately. It is concluded that gas-distillate measurement is still in its infancy, and for that reason many problems have not been solved to the entire satisfaction of the engineers of the manufacturing and operating companies. A. H. N.

43.* **Displacement Meters in the Refinery.** W. H. McCoy. *Proc. Petrol. Fluid Metering Conf.*, 11.4.40, 42–48.—Displacement meters are used in the refineries to measure the rate of crude charge to stills, distillates from the stills to field tanks, fuel oil to burners, fuel oil from burners, liquid propane and butane, cooling oils to glands of hot-oil automatic-control valves, sealing oil to bearings and sealing glands of pumps, transfer of gasoline and other finished products from refinery to bulk terminals, transfer of finished products to distributing pipe-lines, barge calibration, crude sampling, steam condensate, water for cooling purposes, water for chlorination, kerosine, and other side-stream products being run to field, barrelling of oils, pilot-plant measurement, sulphuric acid in treating plants, ethyl fluid for treating gasoline and lubricating oil to bearings. The important items in this long list are treated separately.

In conclusion it is stated that at present the displacement meter is not extensively used in the refinery. This is chiefly because the units as now designed are not well adapted to refinery operation. Their cost of installation, the lack of flexibility, the inability to calibrate them in the field, the generally poor stuffing-boxes, the poor

integrators, and the fact that the bodies, as a rule, do not conform to standard similar to those used by the refineries, all tend to make the refinery engineer hesitate to use this instrument. The poor metallurgical treatment of the working parts has also worked to the detriment of the unit. A. H. N.

44.* Progress in the Use of Meters in Crude Pipe-line Service. T. R. Aude. *Proc. Petrol. Fluid Metering Conf.*, 11.4.40, 49–51.—Orifice meters, recording the rate of flow, have been found most useful when installed in the discharge lines from a pump station for checking the operation of the station and interpreting pressure drops. A decrease in pressure may be caused by a line failure or by trouble in the discharge pumps. A decline in the rate of flow as recorded by the orifice meter indicates that the pressure drop was caused by trouble in the pump station; an increase in the rate of flow with a drop in pressure indicates a line-break.

With regard to displacement meters, experience of 2 years demonstrates that displacement meters for crude-oil pipe-line service have progressed beyond the experimental stage. The cost of maintenance has been negligible. The wear on meters handling clean crude progresses slowly, and the resulting inaccuracies are within reasonable limits, and increase at a steady rate, making it a simple matter to apply a correction factor in figuring oil-runs. Their use has resulted in the elimination of the costs of tankage and labour for measuring oil. A. H. N.

45.* Development of Pipe-line Charts by Dimensional Analysis. L. H. Cherry. *Proc. Petrol. Fluid Metering Conf.*, 11.4.40, 58–64.—During the past twenty years numerous equations have been evolved to calculate variables involved in pipe-line transmission. A survey of recent articles shows the existence of two very apparent facts. First, that there has been a definite lack of correlation of the data recently published in these articles. Second, that, due to the many possible units for viscosity and density, many of the terms called Reynolds numbers, etc., are not the true terms. Equations are derived and curves drawn using such nomenclature, when actually the term used has a number of constant mixed into the true term, and is therefore not truly dimensionless.

The paper shows possible combinations of variables that may be derived by means of dimensional analysis, and submits charts combining these variable combinations in their correct functions according to the latest data available. The basis of the charts is the Fanning equation: $p = 2f\frac{L}{D}\rho\frac{V^2}{G}$.

Weymouth's formula is criticized and an example solved by Weymouth's formula and by means of the charts shows a difference of 17·8% between the two solutions. It is implied that Weymouth's formula is in error. A. H. N.

Chemistry and Physics of Petroleum.

46. *X*-Ray Examination of Poly*iso*butylene. C. S. Fuller, C. J. Frosch and N. R. Pape. *J. Amer. chem. Soc.*, 1940, **62**, 1905–1913.—Brill and Halle (*Naturwissenschafen*, 1938, **26**, 12) found that when poly*iso*butylene of high molecular weight was stretched to the maximum, the amorphous *X*-ray diagram was replaced by a fibre pattern. The work of the authors confirms this finding. Evidence is presented suggesting 1 : 3 arrangement of the methyl-group pairs along the chain and a helical chain configuration.

Natural rubber and poly*iso*butylene show an analogous effect of elongation on their *X*-ray patterns. The fibre pattern of rubber is very weak at elongation of about 100%, and becomes progressively more intense as more crystallinity is produced by further stretching. Poly*iso*butylene of medium degree of polymerization does not show crystallinity on stretching except at elongation above 1000%.

The *X*-ray structure of poly*iso*butylene crystals is discussed, and the paper is illustrated with photographs and diagrams. T. C. G. T.

47. Nitrogen Compounds in Petroleum Distillate. XVIII. Isolation, Ozonization, and Synthesis of 2 : 4-Dimethyl-8-*s*.-butylquinoline. L. M. Schenck and J. R. Bailey. *J. Amer chem. Soc.*, 1940, **62**, 1967–1969.—Continuing their work on the isolation of

kero bases from 320–330° kero base fraction, the authors have succeeded in obtaining yields of a new $C_{15}H_{19}N$ kero base, 2 : 4-dimethyl-8-*s*.-butylquinoline. The structure was determined and the compound synthesized from acetylacetone and *o*-amino-*s*.-butylbenzene. T. C. G. T.

48. Fluorinated Derivatives of Ethane and Ethylene. VI. Corrective Data. A. L. Henne and E. G. Wiest, *J. Amer. chem. Soc.*, 1940, **62**, 2051–2052.—Improved physical data are listed for $CCl_2 = CF_2$,CCl_2CClF_2, CCl_2BrCF_2Br, $CClFBrCClFBr$, and CCl_2CF_2. T. C. G. T.

49. Catalytic Dehydrogenation of Representative Hydrocarbons. A. G. Oblad, R. F. Marschner, and L. Heard. *J. Amer. chem. Soc.*, 1940, **62**, 2066–2069.—Hydrocarbons of all classes have been dehydrogenated over two types of chromic oxide catalyst and at the conditions : temperature 480° C. ; space velocity 0·5 ; duration, 3·0 hr.

*cyclo*Hexanes are converted into aromatics, so, too, are paraffins, but much less rapidly than the *cyclo*hexanes. In the case of paraffins the activity of the catalyst steadily decreases and elementary carbon is deposited. *cyclo*Pentanes dehydrogenate slowly, and resemble olefines in depositing large amounts of carbon.

Simple methylated aromatic hydrocarbons are unaffected, but alkyl aromatics with longer side-chains, such as ethylbenzene, are slowly dehydrogenated to products which strongly poison the catalyst. The residue responsible for the poisoning is a tar rather than carbon. T. C. G. T.

50. Infra-Red Absorption Studies of Some Hydrocarbons. F. T. Wall and G. W. McMillan, *J. Amer. chem. Soc.*, 1940, **62**, 2225–2227.—The infra-red absorption spectra of a number of hydrocarbons in carbon tetrachloride solution have been studied in the 3·35 μ region. The positions of the absorption maxima have been correlated with the aromatic and aliphatic properties of the molecules. T. C. G. T.

51. Effect of Surface on Cool Flames in the Oxidation of Propane. R. A. Day and R. N. Pease. *J. Amer. chem. Soc.*, 1940, **62**, 2234–2237.—There have been several attempts to explain the occurrence of successive "cool flames" during the oxidation of paraffin hydrocarbons. Higher aldehydes, the surface of the reaction vessel, and peroxides have all been advanced as explanatory.

The work of Harris and Egerton indicates that the peroxides are not responsible, and in earlier work (*J. Amer. chem. Soc.*, 1934, **56**, 2034) one of the authors had reached a similar conclusion when he found that by coating a Pyrex reaction vessel with potassium chloride the yield of peroxides could be largely suppressed without materially altering the rate of oxidation of the propane.

In this work the authors find that the cool-flame region in 1 : 1 propane–oxygen mixtures is not materially affected by etching the reaction tube or coating it with potassium chloride. It is therefore determined by conditions in the gas phase. Attention is directed to the region of negative temperature coefficient of the rate as an effective control, leading to successive flames and preventing ignition. T. C. G. T.

52. Quenching of Fluorescence in Solution. II. Temperature and Solvent Effects. R. W. Stoughton and G. K. Rollefson. *J. Amer. chem. Soc.*, 1940, **62**, 2264–2268.—The effects of changes of temperature, viscosity, and dielectric constant of the solvent on the quenching of the fluorescence in solution have been studied. The fluorescent substances used were quinine sulphate, fluorescein, and acridone, whilst the quenchers were potassium chloride and iodide. Water glycol, glycerol, and methyl alcohol, but not oil, were used as solvent. T. C. G. T.

53. Hydrogen Bonds Involving the C–H Link. X. The Solubility of Donor Solutes in Halogenated Hydrocarbons. C. S. Marvel, F. C. Dietz, and M. J. Copley. *J. Amer. chem. Soc.*, 1940, **62**, 2273–2275.—Organic compounds containing donor centres generally are much more soluble in hydrogen-containing halogenated hydrocarbons than in completely halogenated hydrocarbons. These higher solubilities are attributed to solute–solvent association by means of CH⟨– O or CH⟨– N bonds. T. C. G. T.

54. Synthesis of 4 : 5-Dimethylchrysene. M. S. Newman. *J. Amer. chem. Soc.*, 1940, **62**, 2295–2300.—In a study of the relationship between chemical constitution and carcinogenic activity of hydrocarbons, 4 : 5-dimethylchrysene has been synthesized. Evidence supporting the structure is presented. T. C. G. T.

55. Spreading of Binary Mixtures of Volatile Organic Liquids on Water. C. P. Keim and E. R. Washburn. *J. Amer. chem. Soc.*, 1940, **62**, 2318–2320.—Work on the measurement by means of a surface-film balance of the spreading pressures of pure organic liquids on water (cf. I.P. Abs. 1940, No. 1497) has been extended to cover certain binary mixtures such as benzene–toluene, benzene–*cyclo*hexane, benzene–nitrobenzene, and benzene–bromobenzene. T. C. G. T.

56. Notes on the Preparation and Properties of some Aliphatic Hydrocarbons. L. Schmerling, B. S. Freedman, and V. N. Ipatieff. *J. Amer. chem. Soc.*, 1940, **62**, 2446–2447.—The synthesis of three hexanes, one heptane, and three octanes is described. Their boiling points, refractive indices, densities, and octane numbers are given.

2-Methylpentane (C.F.R. Octane No. 71·5) was prepared via 2-methyl-pentanol-4, which was obtained by hydrogenating mesityl oxide.

2 : 2-Dimethylbutane (Octane No. 93) was synthesized by the hydrogenation of *tert.*-butylethylene, which was obtained by the pyrolysis of pinacolyl acetate.

2 : 3-Dimethylbutane (Octane No. 94) was prepared by two methods. The first consisted of hydrogenating dimethylbutadiene obtained by the dehydration of pinacol over alumina at 427° C. The second method consisted of the reduction of pinacolone to pinacolyl alcohol, the dehydration of the alcohol by means of oxalic acid to a mixture of tetramethylethylene and *unsym.*-methyl*iso*propylethylene, and the hydrogenation of these olefins to the desired hexane.

The carbinols which were intermediate in the preparation of 2 : 2 : 3-trimethylbutane (Octane No. 100), 3 : 4-dimethylhexane (Octane No. 84·5), 2 : 2 : 3-trimethylpentane (Octane No. 100), and 2 : 3 : 4-trimethylpentane (Octane No. 94·5), were synthesized by means of the Grignard reaction. The carbinols were then dehydrated and hydrogenated. T. C. G. T.

57. Nature of the Surface of Catalytic Nickel. W. W. Russell and W. V. Loebenstein. *J. Amer. chem. Soc.*, 1940, **62**, 2573–2580.—An account is presented of the selective poisoning of nickel catalysts, and the information obtained on the nature of the active surface indicating it to be non-uniform is discussed. T. C. G. T.

58. Polyalkylbenzenes. XXVII. Preparation of Pure Ethylbenzenes. L. I. Smith and C. O. Guss. *J. Amer. chem. Soc.*, 1940, **62**, 2625–2629.—It has been found that the ethylation of benzene by ethyl chloride and aluminium chloride occurs quite as readily as does the corresponding methylation, and that it is possible to control the alkylation so that the major portion of the product consists of any desired polyethylbenzene. Tri-, tetra-, penta-, and hexa-ethylbenzenes have been prepared by the method.

As in the case of methylation, no vicinal isomers resulted from these ethylations. T. C. G. T.

59. Polyalkylbenzenes. XXVIII. Physical Properties of the Tetraethylbenzenes. L. I. Smith and C. O. Guss. *J. Amer. chem. Soc.*, 1940, **62**, 2630–2631.—Three tetraethylbenzenes have been highly purified and their physical properties determined: *sym.*-tetraethylbenzene, b.pt. 246·8° C. (734 mm.); f.pt. + 10° C.; n_D^{20} 1·5054, and d^{20} 0·8788; *unsym.*-tetraethylbenzene, b.pt. 247·4° C. (734 mm.); f.pt. − 21° C.; n_D^{20} 1·5056; and d^{20} 0·8799.

Vicinal tetraethylbenzene, b.pt. 251·1° C. (734 mm.); f.pt., fluid at − 50° C.; n_D^{20} 1·5125; and d^{20} 0·8875.

Vapour pressures are also presented. T. C. G. T.

60. Jacobsen Reaction. VII. Polyethylbenzenes. L. I. Smith and C. O. Guss. *J. Amer. chem. Soc.*, 1940, **62**, 2631–2635.—To obtain information concerning the

Jacobsen rearrangement of ethylated benzenes, six polyethylbenzenes, 1 : 2 : 4- and 1 : 3 : 5-triethylbenzenes, the three tetraethylbenzenes and pentaethylbenzene have been studied. T. C. G. T.

61. Polyalkylbenzenes. XXX. Nitration of Tetra-, Penta-, and Hexa-ethylbenzenes; Bromination of the Tetraethylbenzenes. L. I. Smith and C. O. Guss. *J. Amer. chem. Soc.*, 1940, **62**, 2635;2638.—Nitration of polyalkylbenzenes is of interest not only because the reaction provides good derivatives for identification of these hydrocarbons, but also because of the curious attack on the side-chain, leading to the formation of nitrates, which often accompanies it. Bromination, on the other hand, while a smooth reaction, does not lead to good derivatives in the polymethylbenzene series. Nitration and bromination of three tetraethylbenzenes and penta- and hexa-ethylbenzenes have been studied and the reactions and products compared with those of the corresponding polymethylbenzenes. T. C. G. T.

62. Polyalkylbenzenes. XXXI. Preparation and Physical Properties of 1 : 2 : 3-Trimethylbenzene (Hemimellithene). L. I Smith and L. J. Spillane. *J. Amer. chem. Soc.*, 1940, **62**, 2639–2642.—1 : 2 : 3-Trimethylbenzene (hemimellithene) is not formed when xylenes are methylated by methyl chloride and aluminium chloride, nor can it be obtained from the other trimethylbenzenes by a Jacobsen rearrangement. Several methods have been used for this synthesis, but the authors have used a modification of the Tawney–Agre method which, utilizing the Tiffeneau rearrangement, prepared the compound from benzyl chloride.

The physical properties of the purified product were: d_4^{20} 0·8944 (d_4^0, d_4^{25}, and d_4^{30} are also presented), n_4^{20} 1·5130 (n_D is also reported at 5, 10, 15, 25, and 30° C.) and f.pt. − 25·41° C. Vapour-pressure/temperature relationships are also presented. T. C. G. T.

63. Cyclization of Dienynes. VIII. Ring Closures with α- and β-*cyclo*hexenyl-acetylene Derivatives of Octalin. C. S. Marvel, D. E. Pearson, and L. A. Patterson. *J. Amer. chem. Soc.*, 1940, **62**, 2659–2665.—The cyclization reaction which occurs when substituted dienynes are treated with sulphuric acid has now been extended to some α and β derivatives of octahydronaphthalene. T. C. G. T.

64. Structure of Vinyl Polymers. IX. Catalysts. C. S. Marvel and E. H. Riddle. *J. Amer. chem. Soc.*, 1940, **62**, 2666–2670.—Evidence is presented showing that vinyl polymers formed by the action of catalysts such as peroxides and boron fluoride or by photochemical activation have the same arrangement of monomeric units in the polymer chain. T. C. G. T.

65. Sulfhydryl and Cysteine Derivatives of 1 : 2-Benzanthracene, 10-methyl-1 : 2-benzanthracene and 3 : 4-Benzpyrene. J. L. Wood and L. F. Fieser. *J. Amer. chem. Soc.*, 1940, **62**, 2674–2681.—The sulfhydryl and cysteine derivatives of highly carcinogenic hydrocarbons such as 1 : 2-benzanthracene, 10-methyl-1 : 2-benzanthracene and 3 : 4-benzpyrene offer a source of information concerning the nature and significance of the reaction involved in the metabolism of carcinogenic hydrocarbons.

The dihydroxydibenzanthracene synthesized by the authors is believed to be identical with the substance excreted by carcinogenic-hydrocarbon-injected mice and rats. As the excreted substance is the product of natural detoxification, any measures which promote that conversion should be advantageous. T. C. G. T.

66. Macropolymerization: the Mechanism of Activation. E. P. Irany. *J. Amer. chem. Soc.*, 1940, **62**, 2690–2698.—Macropolymerization is usually explained as a chain reaction which is supposed to be initiated and propagated by radicals produced by the opening of the double bond of the monomer. This conception is inadequate for many reasons, which are discussed. The evidence for the discussion is based largely on styrene polymerization. T. C. G. T.

67.* Studies on the Separation of Paraffin Waxes. Part 1. Principles Involved in the Fractional Melting of Wax. M. F. Sawyer, T. G. Hunter, and A. W. Nash. *J. Inst. Petrol.*, 1940, **26** (202), 390–400.—In this, the first part of the paper, a fundamental basis of classifying and identifying fractions of wax in equilibrium experiments is discussed. A "calculated molecular weight" of wax is explained, together with its use in the experiments which are to be reported in later parts. A. H. N.

68.* Chlorination of Methane for the Preparation of Carbon Tetrachloride. A. I. Kiprianov and T. S. Kusner. *Oil Gas J.*, 18.1.40, **38** (36), 49.—Investigations have been carried out on an improvement of the method of Jones, Allison, and Meighan (*Ind. Eng. Chem.*, **11**, 639 (1919)) for the production of CCl_4 by direct chlorination of methane at 400° C. in the presence of activated carbon as catalyst. This method avoids the danger of ignition of the reacting gases when excess Cl_2 is used, but the maximum velocity of Cl_2 attained is too slow for commercial exploitation (12 litres per 100 gm. of activated carbon). Increasing the velocity caused ignition, but it was found that by diluting the reacting gases with inert gases this could be avoided. In practice natural gas containing CO_2 and N_2 could be used. The reaction takes place in a narrow zone, so that widening the combustion tube is an advantage. The highest volume velocity (160 litres Cl_2 per 100 gm. of carbon per hour) was attained using 32 litres CH_4, 128 litres Cl_2, and 250 litres HCl, giving a yield of 94% of the theoretical, with only slight incandescence in the tube. Tests showed that there was no danger of the gas mixture exploding during chlorination. C. L. G.

69.* Temperature-Gravity Graph for Gravity Determinations. O. G. Vanderveer. *Petrol. Engr.*, Dec. 1939, **11** (3), 56.—A graph is reproduced enabling the gravity of petroleum oils between 10 and 100 to be converted from that at any temperature between 0° and 180° F. to that at any other temperature. It is based on the A.P.I. gravity tables in the Tag Manual, the smooth curves being drawn between the points on the graph. Differences resulting from this are, however, small for the variations in temperature normally encountered. For accurate gravity determinations, as for purchasing, direct determinations of the gravity of the oil brought to 60° F. is advisable. C. L. G.

70.* The Dependence of Viscosity of Liquids on Constitution. A. H. Nissan, L. V. W. Clark, and A. W. Nash. *J. Inst. Petrol.*, 1940, **26** (198), 155–211.—A study of the correlation of viscosity and molecular shape of liquids is presented. Liquids appear to obey one law of viscosity–temperature variation, independently of whether they are associated, unassociated, or dissociated. Molecular shape appears to be of greater importance than molecular weight in determining the "specific viscosity curve." A. H. N.

Analysis and Testing.

71.* Burning Test for Kerosine. I.P.T. Serial Designation—K 35(T). Anon. *J. Inst. Petrol.*, 1940, **26** (196), 91–95.—This method supersedes that issued in 1938. A. H. N.

72.* Simple Petroleum Tables for Use with Density Hydrometers. V. Stott. *J. Inst. Petrol.*, 1940, **26** (199), 235–245.—Tables showing change of density of petroleum oils with temperature and for conversion of density in g./ml. to weight in air in lb./Imp. gal. are given. A note is appended on the accuracy of density determinations by means of British Standard density hydrometers. A. H. N.

73.* Analysis and Testing of Lubricating Greases. M. W. Webber. *J. Inst. Petrol.*, 1940, **26** (200), 273–293.—The paper deals solely with soap greases, and discusses the determination of soap base and content, mineral-oil content, free acid and alkali, water content, unsaponified fat, ash, impurities, fillers and addition agents, corrosion, melting point, consistency, stability at high and normal temperatures and at high pressures and on storage, load-carrying capacity, and low-temperature efficiency.

See also Abstract No. 85. A. H. N.

Motor Fuels.

74.* Alternative Fuel. L. van Lottom, *Auto. Engr*, 1940, **30** (399), 219–220.—For motor vehicles, butane has the advantage of a relatively low vapour pressure, and thus does not require a high-pressure storage cylinder. However, the cooling effect of evaporation leads to starting difficulties in cold weather, whilst the higher temperatures under the bonnet may cause vapour lock. These difficulties may be overcome by the use of *iso*butane or a 35/65 mixture of propane and butane.

It was found that 28 lb. of butane was equivalent in heat value to 3·89 lb. of petrol. Tests on an E.6 Ricardo engine showed that the highest compression ratios at which petrol and butane could be used were 5·5 : 1 and 8·5 : 1, respectively. Maximum power was 11·9 h.p. for butane and 10·5 h.p. for petrol. Consumption of butane, expressed as equivalent pints of petrol per B.H.P. hour, was somewhat higher than with petrol. K. A.

75.* Octane Ratings of a Number of Pure Hydrocarbons and of some of their Binary Mixtures. J. Smittenberg, H. Hoog, B. H. Moerbeek, and M. J. v.d. Zijden. *J. Inst. Petrol.*, 1940, **26** (200), 294–303.—C.F.R.–A.S.T.M.-Motor method octane numbers have been determined of fifty hydrocarbons, the majority of which were in a very pure state, and of certain binary mixtures. A method is described by means of which the octane numbers below zero and above 100 were estimated. A. H. N.

Lubricants and Lubrication.

76. Study of Monolayers of some Esters and Chlorinated Derivatives Possibly Useful as Lubricating Addition Agents. G. L. Clark and J. V. Robinson. *J. Amer. chem. Soc.*, 1940, **62**, 1948–1951.—The work is inspired by the oil industry's need for knowledge of the mechanism of action of certain polar organic compounds, which, when added to lubricating oil, increase its " oilness." Of the various theories of this mechanism the one considered in this investigation is that the addition agent is absorbed on the metal, acting as a buffer between metal surfaces. *X*-Ray diffraction has been used previously by one of the authors to show that such an absorption actually takes place.

The monomolecular film balance was selected as a tool to furnish quantitative data on the strength of absorption, and the nature of the molecular packing of material used as " oilness " agents.

It is suggested that the collapse-pressure of monomolecular films measured on the hydrophil balance may be correlated with the resistance to shear of the same substances oriented on a metal surface in an engine bearing. It is also suggested that a surface consisting of a close-packed array of hydrogen atoms, attached to hydrocarbon chains, should offer the minimum hindrance to the hydrocarbon molecules of a lubricating oil slipping over it.

With an improved film balance under carefully controlled conditions, measurements are made of area per molecule and collapse pressure on water surfaces for monolayers of certain esters which have possible use as addition agents in lubricating oils—namely, methyl stearate, L-chlorostearate, dichlorostearate, oleate ricinoleate and chlororicinoleate, ethylene glycol distearate and ricinoleate and tricresyl phosphate.

T. C. G. T.

77.* Notes on Filtration and Distribution of Lubricating Oil. T. C. Worth. *J. Inst. Aut. Engrs*, Nov. 1940, **9** (2), 13.—Contaminants which affect the properties of used oils are considered, and figures for analyses of used oils from a petrol and a diesel engine are given. Methods of oil conditioning include gravitation, straining, adsorption, filter aids, and electrostatic precipitation, with filtering divided into suction, strainer, full flow, by-pass, and batch-filtration methods, each being considered in that order. With the exception of adsorption and filtration, other than the batch-method, the methods are impracticable in an automobile engine. That adsorption is the chief factor in clearing oil by filtration is the conclusion reached from experiments on the effectiveness of various materials for use in filters. The possibility of

chemical aids to produce a really clean oil is discussed, as is the location of the various types of filter, and it is stated that, in the majority of cases, a full-flow filter is no more than a badly designed by-pass filter.

A method of testing filters and examining pressure drop is described, as well as the difficulties of obtaining a representative material for tests. In an appendix an electrical phenomenon is described which appears to have a direct relation to filtration and the material used for the filter, and which shows a maximum value at a definite pressure. This pressure coincides with that used for many by-pass filters.

H. L. W.

78.* Static Friction of Lubricated Surfaces. A. Fogg and S. A. Hunwicks. *J. Inst. Petrol.*, 1940, **26** (195), 1–18.—Details and conclusions of an investigation carried out to obtain information on boundary friction and the boundary lubricating properties, or oiliness, of various substances are presented. Oiliness appears to be unconnected with viscosity of the fluid; but it is connected with the properties of the boundary layer. A. H. N.

79.* Catalytic Effect of Metals on the Ageing of Lubricating Oil for Diesel Engines. H. L. Matthijsen. *J. Inst. Petrol.*, 1940, **26** (196), 72–90.—Catalytic effect of all relevant metals with which lubricating oil comes into contact in the Maybach diesel engine is examined and the results are reported. All the ferrous metals are found to stimulate ageing, whilst the effects of non-ferrous metals are either nil or negative.

A. H. N.

80.* Some Experiments on Seizure between Lubricated Hard Steel Balls. D. Clayton. *J. Inst. Petrol.*, 1940, **26** (199), 256–271.—Experiments and results are described, to find the effect of change of the test conditions on the behaviour of lubricants in the four-ball apparatus. Similarly, the effects of mechanical adjustments in the machine itself on seizure and lubrication results are reported. A. H. N.

Asphalt and Bitumen.

81. Revised Specifications for Cut-back Asphalts. Anon. Asphalt Institute Construction Series No. 51, 1940.—The Asphalt Institute specifications for cut-back asphalts have been revised in the light of experience gained during the past seven years. The three types of material, R.C., H.C., and S.C., have been divided into six grades, and viscosities adjusted, so that each product of the same grade is of the same viscosity, the upper limit is twice the lower, and a gap exists between consecutive grades. For R.C. and M.C. materials the amount of distillate received at specified temperatures is expressed as a percentage of the total recovered at 680° F., a minimum recovery at 500° F. is now included, the minimum recovery at 600° F. has been increased for R.C. materials, and the maximum recovery at 437° F. and 500° F. for M.C. materials is lower than minimum figures for R.C. products.

A minimum is prescribed for percentage of residue from distillation, the lower penetration limits have been increased to 80 for R.C. materials and to 120 for M.C. materials, and the minimum ductility has been increased to 100. In the case of residues of more than 200 penetration the material is acceptable if the ductility is over 100 at 60° F. The limits in the solubility test are retained, but carbon tetrachloride is to be used instead of carbon disulphide. The specifications are tabulated and indications given as to the product to be used for particular purposes and of the working temperatures. A. O.

82. Revised Specifications for Slow-curing Liquid Asphaltic Road Materials. Anon. Asphalt Institute Construction Series No. 52, 1940.—The revised Asphalt Institute specifications for slow-curing materials are tabulated, and it is pointed out that these include requirements for percentage and ductility of 100 penetration asphalt residue, maximum and minimum limits for the flood test on residue from distillation, and freedom from water in all but the two highest grades. A. O.

83. Specifications for Emulsified Asphalts. Anon. Asphalt Institute Construction Series No. 53, 1940.—Specifications for rapid, medium, and slow-setting emulsions are tabulated, and an indication is given as to the principal uses of the emulsions. The methods of testing are those described in the A.S.T.M. methods of Testing. A. O.

84.* Stability of Emulsions, Part III. General Survey of Solid Emulsifying Agents, with Special Reference to the Hydrous Oxides and Hydroxides. H. L. Bennister, A. King, and R. K. Thimas. *J. Soc. Chem. Ind.*, 1940, **59**, 226–232.—It is pointed out that to give oil-in-water emulsions the solid agent used must be more easily wetted by water than by oil, and vice versa for water-in-oil emulsions. Among materials which have been used for the former are plaster of Paris, silica, lime, calcium carbonate, fine clays, and powdered coal, and for the latter, carbon-black. The efficiency of emulsification depends on the particle size of the emulsifier, which also determines the size of the emulsified droplets. Previous work is discussed, and it is pointed out that solid emulsifiers have only a limited general application, the most common being bentonite for asphaltic bitumen emulsions. The solid emulsifying agents in general give very coarse unstable emulsions. Unlike Parts I and II, the present work is only a qualitative survey. A gelatinous precipitate was found to be usually much more efficient than a granular preparation of the same material. The authors examined many inorganic solids, and concluded that the hydrous oxides and hydroxides were the most effective. The oxides and hydroxides of seventeen metals and silicon were precipitated by a number of methods and their emulsifying properties examined, and the results are given in detail, suitable symbols being used to grade the resultant 50% emulsions of carbon tetrachloride, paraffin, and carbon disulphide. The emulsifying efficiency varied very much with the method of precipitation, very gelatinous, highly dispersed systems being in general most effective. Many of the hydroxide precipitates improved or deteriorated on ageing, and aged aluminium hydroxide was found to be particularly good. Emulsions stabilized by gelatinous hydroxides were found to be relatively coarse, although very stable and insensitive to the presence of electrolytes, and with a pronounced tendency to cream and form "clumps." As a general rule, it appeared that for a given compound those specimens precipitated at either very high or very low concentration had maximum emulsifying capacity, and ammonia appeared to be the best precipitating agent. Froth formation was noticeably absent with all these emulsions. Magnesium and aluminium compounds were especially efficient, whilst copper hydroxide should be useful owing to its additional value as a fungicide. Addition of traces of alkali, minute amounts of soaps, and other surface-active compounds considerably improves the dispersions, as does the precipitation of the hydroxides from solutions containing about 1% of hydrophilic colloids. The hydrous precipitates also possessed the ability to wet substances, such as sulphur and various pigments, which are not easily wetted. Gelatinous precipitates other than oxides or hydroxides were found to be ineffective—*e.g.*, silica gel, magnesium, zinc, and aluminium silicates. It was concluded that the basic character of the oxides and hydroxides was a fundamental property necessary for emulsification. The paper concludes with the experimental details of the methods of preparing some of the hydroxides. H. G. W.

85. Flow Properties of Asphaltic Bitumens with Reference to Road Behaviour. A. R. Lee and J. B. Warren. *Proc. Ass. Asph. Pav. Technol.*, 1940, **2**, 340–364.—The effect of stress and temperature on the viscosity of different types of bitumen has been examined as part of an investigation of the significant physical properties of bitumen in relation to road behaviour. A similar examination of the flow properties of asphaltic road mixtures is in progress, and a study is being made of the behaviour of asphaltic materials under normal traffic conditions.

The instruments used to cover the range of viscosities between atmospheric and mixing temperatures were: a rotating coni-cylindrical viscometer, an Ostwald viscometer for opaque viscous liquids, and a falling cylinder viscometer. These instruments are discussed. Measurements on a 65 pen. Mexican bitumen showed that viscosity diminished with increasing shearing stress at temperatures below 70° C., whilst at higher temperatures the bitumen behaved as a Newtonian liquid.

The relation between shearing stress and rate of shear did not obey the Bingham

law $D = 1/\eta(S - S_0)$, and could not be represented by other equations, but could be expressed to a first approximation by $D = kS^{\rho}$, k and ρ being constants, except for bitumens deviating markedly from Newtonian flow.

It is thought that an equation introducing one term representing Newtonian flow and a second term representing additional flow due to breakdown of the structure would be more logical, but without a value for viscosity at zero stress this cannot be satisfactorily checked.

The value of ρ in $D = kS^{\rho}$ gives a measure of the deviation from Newtonian flow and provides a method of expressing the degree of plasticity.

Examination of a number of 65 pen. bitumens indicated a tendency for asphaltene and plastic flow index to increase together.

Differences in viscosity of bitumens of the same penetration are said to affect directly the mechanical properties of surfacing materials containing the bitumens.

In discussing the effect of temperature on viscosity it is pointed out that bituminous materials present particular difficulty in attempts to obtain a value for the temperature susceptibility of viscosity, owing to their relatively large temperature susceptibilities. It has been found that the equation $k = AT^{-n}$, where T is temperature °F. and A and n are constants, holds for the range from about 20° C. to 90° C. The coefficient n, the slope of the straight line obtained on plotting log k against log T, is termed the logarithmic temperature coefficient, and provides a criterion for distinguishing between the relative susceptibilities of bitumens. No relation was found between asphaltene content and the temperature coefficient.

Specimens of road-surfacing materials have been found to exhibit similar log temperature coefficients, when tested under conditions of steady stress, to those of the bitumens, and it is concluded that the susceptibility of the road mix is determined by that of the binder. It is stated that it is not clear what significance the elastic properties of a bituminous binder have in respect of road behaviour. The elastic properties are most prominent when the stress is rapidly applied, but even under conditions of continuously-applied constant stress elastic recovery occurs on the sudden removal of the stress. The amount of recovery depends on the stress applied and the degree to which the material has been previously sheared.

The evaluation of the elastic constants is said to offer some difficulty, but the total recovery gives an adequate means of distinguishing this property. Results obtained indicate that the elastic properties are directly related to the asphaltene content. A. O.

86. Developments in Research and Technology of Bituminous Road Materials. G. W. Eckert. *Proc. Ass. Asph. Pav. Technol.*, 1940, **2**, 365–431.—The author reviews the literature dealing with the manufacture, properties, testing, and application of bituminous materials published during 1939. A. O.

87.* Physical Constants of Asphaltic Bitumens. Part 1. R. N. J. Saal, W. Heukelom, and P. C. Blokker. *J. Inst. Petrol.*, 1940, **26** (195), 29–39.—A survey is given of the following physical properties of asphaltic bitumens: specific gravity, coefficient of cubical expansion, specific heat, thermal conductivity, permeability to water vapour, surface tension, and total surface energy.

The methods by which these properties have been determined are described in detail. A. H. N.

88.* Flow Properties of Bituminous Materials. A. R. Lee, J. B. Warren, and D. B. Waters. *J. Inst. Petrol.*, 1940, **26** (197), 101–128.—The effects of stress and temperature on the flow properties of various types of bitumens and bitumen-aggregate mixtures are reported, as obtained by a viscometer and by beam and tensile tests. A. H. N.

89.* Physical Constants of Asphaltic Bitumens. Part 2. J. Saal, K. Meinema, and P. C. Blokker. *J. Inst. Petrol.*, 1940, **26** (199), 246–255.—A survey of the following electrical properties of asphaltic bitumens is made: dielectric strength, angle of dielectric loss, dielectric constant, and electrical conductivity. The methods by which these properties have been determined are described. A. H. N.

90.* **Use of a Bitumen Emulsion in Soil Stabilization.** A. E. Lawrence. *J. Inst. Petrol.*, 1940, **26** (201), 357–364.—The underlying principles of soil stabilization are discussed, and certain conclusions, based on American investigation and practice, are quoted. A. H. N.

91.* **Soil Mechanics in Foundation Engineering.** R. L. James. *J. Inst. Petrol.*, 1940, **26** (201), 365–374.—The subject is analysed from structural engineering point of view and certain conclusions are detailed. A. H. N.

92.* **Manufacture and Testing of Roofing-Felts and Damp-courses.** D. M. Wilson. *J. Inst. Petrol.*, 1940, **26** (202), 377–389.—Testing methods to evaluate the qualities of roofing-felts and damp-courses are described and the manufacture of these materials is described and well illustrated by photographs. A. H. N.

93.* **Researches on Asphaltenes. Part 1.** F. J. Nellensteyn and J. P. Kuipers. *J. Inst. Petrol.*, 1940, **26** (202), 401–406.—The solubility of asphaltic bitumen in solvents having the same surface tension (ether and petroleum spirit) is made the subject of detailed study. It appears ether should be used in preference to normal gasoline for asphaltene determination. A. H. N.

Special Products.

94.* **Hazards Associated with Butadiene and its Peroxides.** D. A. Scott. *J. Inst. Petrol.*, 1940, **26** (199), 272.—Butadiene may form explosive compounds on heating under pressure, or on contact with air or oxygen giving explosive peroxides. Storage over caustic soda or washing with the alkali frees butadiene from its peroxides and their hazards. A. H. N.

95. **Isolation and Identification of Fluoranthene from Carbon Black.** J. Rehner. *J. Amer. chem. Soc.*, 1940, **62**, 2243–2244.—It is known that fluoranthene can be prepared by the dry distillation of coal or coal-tar, or by the passage of acetylene and hydrogen through a hot porcelain tube. It has also been demonstrated that the waxy material deposited from the hydrogen stream during the cracking of natural gas consists partly of acenaphthylene and pyrene.

The author has isolated fluoranthene in the hydrocarbon-soluble fraction of carbon produced by the thermatomic process. T. C. G. T.

See also Abstract No. 93.

Detonation and Engines.

96.* **The Manufacture and Use of Tetraethyl-Lead.** G. Edgar. *J. Inst. Petrol.*, **26** (197), 146–149.—The chemistry of the manufacture as well as historical and operational reviews of the use of tetraethyl-lead are presented. A. H. N.

97. **Fuel Economy in Petrol Engines.** W. T. David and A. S. Leah. *J. Instn. Mech. Engrs*, Oct. 1940, and *Proc.*, 1940, **143** (5), 289–312.—Petrol engines differ widely in their performance, even when due allowance is made for differences in compression ratio, mixture strength, and the nature of the fuel. The object of the paper is to provide data whereby the margin of improvement practically possible for any given engine may be estimated, and to suggest broadly how it may be secured.

The paper is divided into three parts. In Part I are given charts from which may be found the indicated thermal efficiency, fuel consumption per I.H.P.-hour and I.M.E.P. which are attainable in a compact combustion-chambered engine of any bore between 3 in. and 8 in., for compression ratios between 4 : 1 and 9 : 1, speeds from 1000 r.p.m. upwards, and mixture strengths between 20% weak and 20% rich. Separate charts are presented for octane, ethyl alcohol, and benzene. Hence data in regard to any mixed petrol may be deduced with fair accuracy.

The charts are based on the accurate gaseous internal energies, entropies, and

dissociation constants derived from spectroscopic data by means of quantum statistics. Allowance has been made for unavoidable heat losses during explosion and expansion, using heat-loss estimates deduced from closed-vessel explosion experiments and single-cylinder engine-test results. The comparison of the performance of actual engines with the attainable efficiencies shown by the charts yields a measure of the margin of improvement practically possible.

Comparison of the charts shows that, for the same suction temperature, the attainable fuel consumption (lbs. per I.H.P.-hour) is some 10% less for octane than for benzene, although the latter can attain 2½% greater power. With ethyl alcohol the attainable power is very slightly less than with octane, whilst the attainable fuel consumption is very much higher.

Included in Part I are tabulated data on internal energies, constant-volume entropy values, and dissociation constants for gases entering into the combustion reactions. In Part II various phenomena associated with the working fluid and the combustion of the charge are discussed. These include turbulence and its effect on heat loss during explosion and expansion, the delay period after ignition, incomplete combustion at the peak pressure, and after-burning. It is deduced that, in an engine of 4·5-in. bore running at 1500 r.p.m., the heat loss would be about 1% (of the heat of combustion of the fuel burnt) during explosion and about 5% during expansion. Under detonating conditions the rate of heat loss is greatly increased; this is mainly attributable to greatly augmented turbulence, caused by the sudden expansion of the detonated gas into the gas previously burnt.

Part III is a discussion of actual engine performance compared with attainable performance. An example is quoted of a "good" engine, yielding an indicated thermal efficiency of 35·7%. The charts show an attainable efficiency of 38·0%. The defect in efficiency is thus 2·3% of the heat of combustion. This could be accounted for on the assumption that only 70% of the heat energy of combustion had been released at the moment of attaining maximum pressure. If perfect mixing of the charge could be secured, an increase in power of at least 6·25% would be realized.

Apart from distribution difficulties in multi-cylinder engines, it is believed that improvement in charge mixing within each cylinder would be one of the major lines along which progress could be made. K. A.

98. Problem of Valve-stem and Valve-head Deposits. A. T. Colwell. *J. Soc. aut. Engrs*, Sept. 1940, **47** (3), 358.—Whilst much attention has been directed to varnish and lacquer deposits, little thought appears to have been given to valve deposits. The latter may contain lead in various forms, as well as silica, iron oxide, insolubles, and dirt impurities. The real cause of the trouble is the fuel and partly burned lubricating oil, which, collecting on the upper part of the stem, eventually holds the valve open. A valve may continue to operate satisfactorily over a long period when seating properly, but once it is unseated, trouble always occurs. The remedies which have been applied suggest that each engine has individual characteristics, more or less oil having beneficial effects in different cases. The types of deposit are enumerated, and it is shown that oils appear to have a critical temperature at which they leave a maximum deposit. This fact suggests that by controlling the temperature of the valve and metering the oil supply, the deposits should be kept below harmful proportions.

Remedies found useful in the aircraft field are described; metering the oil and eliminating water and acid vapours have proved beneficial. Sodium-cooled valves have reduced one type of deposit, but, unless the guide is thoroughly cooled, may cause varnish on the stems. The low-temperature driving with automotive engines, as well as the variety of fuels and oils used, make the problem more difficult in this case. The oil has not always been found to be the cause of the trouble, but in some cases the fuel is directly responsible, particularly in lean-mixture operation, and many mechanical alterations have been found effective, as also have solvents. Cool running—*e.g.*, many stops and starts with short runs in between—provide the condition for maximum build-up. The author concludes that insufficient attention has been paid to this problem by those workers concerned with fuels and lubricants.

H. L. W.

99. Control of Smoke in the Automotive Diesel. W. W. Manville, G. H. Cloud, A. J. Blackwood, and W. J. Sweeney. *J. Soc. aut. Engrs*, 1940, **47** (4), 397–406.—The acceptance of automotive diesel engines in the U.S.A., particularly for bus service, has been retarded by smoky exhausts and users have tended to resort to lighter fuels, which have been found to effect an improvement. Since English engines give satisfactory results on the heavier fuels, a study of the possible factors controlling smoke was undertaken.

Three laboratory engines of representative type were used, and smoke density was measured by a photo-electric device. The influence of different factors on smoke was investigated both under equilibrium and accelerating conditions. Field tests also were run on a variety of equipment.

Some fifty fuels were tested, and it was established that the most important fuel characteristic influencing smoke is volatility. Whereas the lighter fuels cause less smoke, they also give less power. The conclusion was reached that the major part of the smoke reduction generally attributed to change in fuel is actually due to the resultant change in power output. At equivalent power outputs there are only small differences in the smoking tendencies of fuels covering a wide range of fuel volatility. The effect of cetane number is less important than that of volatility, except in cases where the ignition quality is below the minimum demanded by considerations of roughness and cold starting.

Whilst the original purpose of the study was to concentrate on the relation between fuel properties and smoking, it became apparent that operating conditions, engine design, mechanical condition, and adjustment might far outweigh any possible effect of fuel.

It is concluded that freedom from smoke can be achieved only by accepting a limitation on power output, whether this is brought about by resetting the fuel-pump adjustment or by the use of lighter fuels. It would appear more desirable to reset the smoke stop on the pump whilst retaining the economic advantage of the heavier fuel, which will have the higher calorific value per gallon. This conclusion is substantiated by the London buses, which develop no objectionable smoke on fuels of 550° F. mid-boiling point, but which have power units of sufficient size to permit working below the critical power point. K. A.

Coal and Shale.

100.* Classification of Oil Shales and Cannel Coals. A. L. Down and G. W. Himus. *J. Inst. Petrol.*, 1940, **26** (201), 329–348.—Attention is directed to the confusion which exists in the nomenclature and classification of naturally occurring oil-yielding materials. A system of nomenclature based on the principal plant and mineral constituents, and a classification showing the inter-relationships and gradation of properties of these substances, are put forward. A. H. N.

BOOK REVIEWS.

The Design of High-Pressure Plant and the Properties of Fluids at High Pressures. By Dudley M. Newitt. Pp. viii + 491. Oxford University Press. 1940. Price 35*s*.

During the past twenty years the successful application of high pressures to the chemical industry has resulted in a very considerable study of the properties of matter and of the kinetics of chemical reactions at high pressures. In this book Professor Newitt has confined himself to describing the effects of pressure on physical processes occurring in fluid systems.

The book is divided into two parts. Part I is devoted to the design of high-pressure equipment, and commences with a chapter on materials of construction, followed by one on gas cylinders. Chapter III, on "The Calculation of Stresses and Strains in Pressure Vessels," leads up to a very informative discussion on "The Design of High-Pressure Plant and Equipment" in Chapter IV. Joints, valves, compressors, pumps and safety devices are dealt with, together with the use of glass in high-pressure work. Part I concludes with a chapter on "The Measurement of High Pressures." The material dealt with and the examples of vessels and auxiliary parts presented are such as would be employed in laboratory or small-scale experimental work. This section of the book is obviously written as a result of academic rather than industrial experience, and certain minor problems in technique which quite frequently occur in industrial high-pressure work are not included. The heating of high-pressure vessels, the design of glands and of flow-meters for measuring fluid flows, for example, are not dealt with. While such matters are in the main minor problems, they can be and have been in the past major problems in high-pressure work. One has only to recall the difficulties encountered by Bergius in the heating of his semi-scale hydrogenation convertors, and in the design of a satisfactory gland for these same reaction vessels, to appreciate the important part played by such matters in high-pressure work. Apart from these, the measurement of fluid flows, particularly small gas flows, at high pressures, would make a useful and attractive addition to the book.

The thirteen chapters of Part II deal almost exclusively with the physical properties of fluids at high pressures. After a short introduction dealing with the kinetic theory, the P.V.T. relationships of gases and the equation of state problem are discussed. Recent compressibility work and the volumetric behaviour of the more important gases, some of their binary mixtures, and one ternary mixture are described. The liquefaction of gases, and the use of enthalpy–entropy and temperature–entropy diagrams in the design of gas compressors and circulators are discussed.

The influence of pressure on the viscosity, the dielectric strength and refractivity of gases is reviewed in two chapters, whilst another describes the effect of pressure on the viscosity and refractivity of liquids. The final chapter describes the P.V.T. relationships of liquids.

Tables of data on the thermodynamic properties of hydrogen, nitrogen, carbon monoxide, carbon dioxide, and methane constitute Appendix I. Appendix II is mainly concerned with data on the Joule–Thompson coefficient for nitrogen, air, helium, and argon, whilst Appendix III tabulates the refractive index of carbon dioxide. Numerous data in tabular and diagram form are also included in the text.

It is very obvious from a perusal of Part II that, as pointed out in the Preface, "there is still a serious lack of fundamental data of all kinds relating to condensed systems." The very clear and concise way in which Professor Newitt has presented

the existing knowledge on the fundamental physical properties of fluids under high pressure in this volume should, however, do much to encourage further exploration of this fascinating and important field of research, whilst the description of experimental equipment and methods included will be found particularly helpful to investigators engaged on such high-pressure research. T. G. HUNTER.

Symposium on New Materials in Transportation. American Society for Testing Materials, Philadelphia, Pa. Pp. 94. Price $1.50.

On a number of occasions recently the American Society for Testing Materials has organized a series of papers bringing together a number of otherwise unconnected industries from some common standpoint. This is particularly appropriate to the A.S.T.M., by reason of the wide range of subjects which come within its sphere, and the papers presented are by the foremost chemists and engineers in the various industries, and are always of special interest.

"Symposium on New Materials in Transportation" represents a series of papers presented at the Detroit Spring Meeting in March 1940, and includes the use of steel and rubber in the automotive industry, of concrete and asphalt in transportation, of fuels and lubricants, together with the first article in this series, which is less general than the other—namely, "Exhaust-Valve Materials for Internal-Combustion Engines." The treatment adopted in the different articles is not the same, but whilst some review general progress and research developments, others are primarily concerned with the developments which are taking place in specifications. Thus in the paper by D. P. Barnard and A. H. Fox, on "Trends in the Properties of Volatile Liquid Fuels," these are discussed from the point of view of specifications and methods of test developed by the A.S.T.M., and the whole review is almost entirely from the American point of view. A series of interesting charts show the trends in properties for motor fuel, domestic furnace oils, and furnace oils over a long period of years. Developments in the automobile industry are given in comparison with the dates when the A.S.T.M. adopted various types of test for motor fuels, and a series of supplementary charts show changes in the properties of various gasolines over the period 1905–1940. These show the continual increase in the anti-knock characteristics of regular gasolines, particularly over the period 1930–1940.

While this is a general review, there are a number of statements made, particularly as regards aviation gasoline, which are not in agreement with the standard methods of test adopted in the U.S. specifications, and from this point of view the article will be found particularly interesting.

"Developments in Lubrication," by J. P. Stewart, R. C. Moran, and O. M. Reiff, is primarily concerned with one specific aspect—namely, the development of certain types of additive for use in automobile oils. On the other hand, the article by B. E. Gray, of the Asphalt Institute, on "Recent Developments in the Use of Asphalt for Transportation Purposes," is a general review of the subject, and will be found to be of particular interest. The subject is treated from a wide viewpoint, dealing with such factors as subgrade design, influence of traffic on design, width of pavement aggregate, together with trends in plant mixtures and special considerations applying to airports and railroads. In this article, again, an independent viewpoint has been taken, and for this reason the treatment is specially welcome, since it leads to a re-examination of ideas currently accepted. Although only three articles have been reviewed in detail, the other reviews are of considerable value to petroleum technologists, since the problems affecting other industries are often of great importance to those primarily interested in petroleum. F. H. GARNER.

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Geology and Development.

101.* Sink-holes Important Feature in Arbuckle Dolomite. Anon. *Oil Gas J.*, 12.12.40, **39** (31), 21.—Sink-holes are common in the Arbuckle lime. In the Silica field of Kansas 36 out of 70 dry holes were due to sink-holes of which there is apparently no surface indication. Their barrenness is due to compacting overlying detritus preventing leaching and subsequent porosity. The fill of these sinks ranged from 14 to 163 ft. In some cases barren sinks were completely surrounded by productive wells, and one sink was only 106 ft. from the nearest producer. The sink-holes occupy only a small area, and rarely exceed the 10 acres allotted to a well. G. D. H.

102.* Wade City–Orange Grove May See Multiple Sand Drilling. N. Williams. *Oil Gas J.*, 12.12.40, **39** (31), 26.—This is already one of the most important producing reserves of the Lower Texas Gulf Coast. There is much productive acreage to be exploited, and some of the sands seem capable of multiple development. A well 1½ ml. south of Wade City and 1½ ml. south-west of Orange Grove may be a new pool or an extension of the Wade City–Orange Grove area. 3 ml. south-east of Orange Grove a new area has been opened at 5139–5143 ft., and a test 3 ml. east of Orange Grove has shown oil and gas at 4863–4875 ft.

Wade City and Orange Grove are separated only by a subsurface fault, the former being on the upthrown north-west side. The throw is 250–300 ft. Wade City production covers 1400 acres, and Orange Grove 600 acres. Wade City began producing with gas-distillate in July 1939 at 4800 ft. in the Pundt sand. Crude oil was found in February 1940 in the McNeil sand at 4900 ft. Orange Grove production began in May 1940 in the Blaschke sand at 5100 ft. This has given most oil, although the Pundt 50 ft. below has given some. Wade City has 70 producing wells, Orange Grove 19.

Wade City gives oil from the Pundt (gas and distillate), Bierstadt, and McNeil sands, whilst the Alice at 5000 ft. has favourable showings. In addition, there are lesser sands and lenses, mainly with gas. The McNeil is the most consistent sand, the others being very variable. Orange Grove has Blaschke, Pundt, and Stillwell (distillate) sands. All the known sands of these fields are Basal Frio and Upper Vicksburg. G. D. H.

103.* Illinois Activity Concentrated on Eastern Side of State. H. F. Simons. *Oil Gas J.*, 19.12.40, **39** (32), 15.—Although Illinois activity has declined generally in recent months, there has been an increase in activity in White, Wabash, Edwards, Gallatin, Franklin, Hamilton, and southern Wayne counties. The fact that White County lies in the deepest part of the Illinois basin discouraged development in the early days. Most of the fields developed in this region are small, for, although there are large anticlines, oil is confined to rather small structures on these larger features. There are several producing sands in this area—East Calvin has six horizons. Except for the McClosky, all the producing horizons at East Calvin are in the Chester series, and include the Tar Springs, Cypress, Benoist, Paint Creek stray, and Aux Vases sands.

The first production in this eastern area was at Aden in 1938. The discovery wells in South-eastern Illinois, their date of completion, depth, producing horizon, and initial production are tabulated. The production, number of wells, etc., for the fields on 1st November, 1940, are compared with the data for 1st January, 1940, and the total output is seen to be nearly quadrupled.

The McClosky wells generally have a higher initial output, but the sand wells are longer-lived. G. D. H.

104.* Argentina's Crude Production up 10% in 1940. R. Silveyra. *Oil Gas J.*, 26.12.40, **39** (33), 78.—Mendoza province has given 90% of the 1,479,745 brl. increase in Argentina's oil production in the first nine months of 1940, and the country's total for 1940 will probably be 20,476,130 brl.—10% above 1939. Comodoro Rivadavia has given 73% of the total for the first nine months of 1940.

At Barrancas a 285-brl. well was brought in at 7382 ft., and this discovery was confirmed by a well 4·35 ml. to the north-west, which came in at 1260 brl./day. Tupungato is now under regular exploitation, and the discovery well has averaged 2190 brl./day during its first eleven months.

Tables show the production during the first nine months of the years 1931–1940, the production of the various regions during the first nine months of 1939 and 1940, the capacities of the refineries in 1940, the amounts of the refinery products and home consumption. G. D. H.

105.* War Exerting Strong Influence on Venezuelan Oil Industry. L. Herrera-Figueredo. *Oil Gas J.*, 26.12.40, **39** (33), 80.—Venezuela's 1940 production is estimated at 186,000,000 U.S. brl., 10·6% less than the 1939 figure, and the exports are probably 161,000,000 brl., or 16·2% less than in 1939. The refinery processing of 17,600,000 brl. of crude in the first nine months of 1940 was 97% above the figure for the same period in 1939.

New fields—San Joaquin, El Roble and Santa Ana—have been brought under development in 1940. San Joaquin had six producing wells up to 1st October, 1940, which averaged 710 brl. of oil/day each. El Roble has two wells which average 2000 brl./day each. Santa Ana has two wells, and lies 25 ml. north-west of Oficina. No. 1 Leona in Anzoategui came in at 1000 brl./day in October. So far tests in Guarico have been unsuccessful. A well has been completed successfully at Los Caritos, Monagas.

The production by fields and companies is tabulated for the first nine months of 1939 and 1940. G. D. H.

106.* Peru's Agua Calientes Field is Developing Normally. L. P. Stockman. *Oil Gas J.*, 26.12.40, **39** (33), 104.—Four wells have now been drilled on the Agua Calientes structure. The first was stopped at 3100 ft. at the beginning of 1939, having failed to give production, although oil and gas showings had been noted. The second gave 750 brl./day of 45° oil at 1175 ft. in February 1939, and was shut in later. The third well farther down the structure failed to produce at 3000 ft., whilst the fourth came in at 200 brl./day at 1180 ft.

The structure has a closure of 3600 ft. Production is from a Cretaceous sand. There is an associated structure to the south-east and extensive seeps occur 20 ml. to the south-west. The crude is of a paraffin base.

Some indications are given of the practical problems involved in the development of this difficultly accessible region. G. D. H.

107.* Four Areas in Brazil Warrant Petroleum Investigation. F. N. Bosco. *Oil Gas J.*, 26.12.40, **39** (33), 120.—(1) The coastal belt about 25 ml. wide, and running for 140 ml. north of Bahia, consists mainly of downfaulted, chiefly lacustrine Cretaceous beds dipping seaward. In the north they are overlain unconformably by Tertiaries, calling for geophysical work. A well drilled slightly north-west of Bahia, near the Lobato seep, had an estimated production of 20–50 brl. of oil/day at 1150 ft. A second well 31 ft. deeper may give 100 brl./day.

(2) The Parana basin is a structural syncline 800 ml. from north to south and 600 ml. wide. It has probably 5000 ft. of Cretaceous, Permo-Triassic, and Devonian beds, including volcanics and intrusives, resting on pre-Cambrian crystalline rocks. Some 38 exploratory wells have failed to find commercial oil accumulations. The limited number of seeps and the igneous activity are thought to be unfavourable features for oil in this region, but deep tests are required for conclusive information.

(3) The Central Amazon valley is also a structural syncline. It is 800 ml. wide, and contains Tertiary, Mesozoic, and Palæozoic beds with several unconformities.

(4) The territory of Acre adjoining Peru is potentially productive. There are

favourable structures which have, however, only been partly tested by single wells. Tertiary, Cretaceous(?), and Palæozoic beds are present.

Stratigraphical tables are given for the first three of these potential oil regions, which are placed in order of their probable importance. G. D. H.

108.* Alaska Devoid of Active Drilling Operations. L. P. Stockman. *Oil Gas J.*, 26.12.40, **39** (33), 140.—The Salmon Creek structure on the eastern side of the Alaskan Peninsula was tested to a depth of 7596 ft., and the well was then abandoned. This failure has caused the abandonment of plans for drilling on four similar structures. It is uncertain whether this latest well stopped in the Lower Jurassic or in the Upper Triassic. The beds proved thicker than was expected. The well-defined Salmon Creek structure covers 20,000 acres.

In 1922 two wells were drilled on the Pearl Creek structure, 25 ml. north-west of Salmon Creek.

There are prominent oil seeps in the Cold Bay region, around Aniakchak Bay and Chignik. In the Cold Bay region they are along anticlinal lines. Both the Salmon Creek and Pearl Creek anticlines have strong seepages.

Apparently the Pearl Creek wildcat stopped 1000 ft. above the Jurassic–Triassic contact. The Jurassic and Triassic rocks appear conformable, but in the absence of fossil evidence, determination of the exact contact is difficult. G. D. H.

109.* Mexico's Production Shows Modest Gain. Anon. *Oil Gas J.*, 26.12.40, **39** (33), 152.—Mexico's production for 1940 is estimated at 43,470,000 brl., an increase of about 1% over 1939. However, the yield for the first nine months was 6% above that for the corresponding period of 1939. Poza Rica has provided about 64% of the 1940 total. Tables show the monthly production and exports up to September 1940.

In September there were 881 producing wells, 95 more than in September 1939. The four main pipe-line systems total 724 ml. in length and handle an average of 112,865 brl. of oil/day, whilst the seven refineries have a daily capacity of 99,800 brl., with cracking facilities for 18,830 brl./day.

The effect of the war on Mexico's oil exports is discussed. G. D. H.

110.* Michigan Getting First Real Deep Exploration. Anon. *Oil Wkly*, 9.12.40, **100** (1), 24.—For fifteen years Michigan drilling has been mainly to the Traverse and Dundee limestones. Little oil has been obtained from other formations, and the few scattered deeper tests have been dry. The Traverse is the main producer in the west, and the Dundee in the centre of the State. Production has fallen off rapidly during 1940.

A deep well is under way to test formations below the Sylvania in the centre of the State. Oil and gas shows are known in the Niagaran, and the Trenton produces in Monroe county. Altogether 15 tests have gone to the Silurian and Ordovician outside the central basin province. The sites and depths of a number of deep tests are listed and some details given of the nearest one to the new well. This new well showed oil in the Sylvania and Monroe, and details are given of the drilling. The Salina of the Silurian was met at 5480 ft. Gas trouble developed at 7368 ft. The Niagaran is expected at 8000–8300 ft., the Trenton possibly at 9200–9500 ft. and the St. Peter at about 10,000 ft.

At Deerfield are 15 Trenton wells. The St. Peter has shown oil on the edge of the central basin.

A generalized geological column of Michigan is included, and there are tables of production, and distribution of the geological formations of the deep discoveries and new producing levels uncovered in the portion of North Texas since 1936, and Michigan wildcat results since 1931. G. D. H.

Drilling.

111.* Temperature Surveys in Oil Wells. C. V. Millikan. *Petrol. Tech.*, Nov. 1940, A.I.M.M.E. Tech. Pub. No. 1258, 1–8.—The thermometers should read to 0·2° F. or less and have a low thermal lag. Vapour-pressure and expansion types are easily manipulated in the well, being self-contained, but the temperature record cannot be

seen until the run is completed. The more sensitive electrical resistance type records at the surface, but requires more elaborate equipment.

If possible the part of the hole to be examined should be filled with liquid. The value of the temperature survey depends on the successful interpretation of the anomalies. The well should be in such a condition as to give the greatest temperature anomalies, and the run should be made not too soon after shutting in, but before temperature equilibrium has been attained. Stratigraphical determinations are possible from temperature surveys in certain well-developed fields. Gas sands can be picked up from temperature anomalies (lows), as can the gas–oil contact in a producing well. Thief formations, water sources, and casing leaks can also be determined. Cement setting behind casing can be located by the heat generated.

Examples are given of these various uses of temperature surveys, and the conditions for best results are described in each case. G. D. H.

112.* Fewer Casing Sizes in New A.P.I. Specifications. Anon. *Oil Wkly*, 9.12.40, **100** (1), 34.—Adoption of a new casing list, designed to reduce to 86 from more than 200 the number of sizes, weights, and grades of casing, was recommended to the American Petroleum Institute by its Division of Production Committee on Standardization of Oil Country Tubular Goods. The simplified list is being studied for final ratification.

The list was formulated and is being revised to contain all casing which may be required for drilling oil wells to any depth. Details of the sizes and grades recommended are presented.

In arriving at the 86 items in the list (4½-in. to 13⅜-in. range), an attempt was made to establish increments of about 1000 lb. in minimum collapsing pressures for the smaller sizes. The outer diameter increment for these sizes approximates ½ in. Between 4½-in. and 7⅝-in. sizes, the ½-in. is approximately maintained, whilst from 7⅝-in. to 11¾-in. sizes the 1-in. increment is the unit. In the larger popular sizes (8⅝-in. to 13⅜-in.), minimum collapsing pressure increments are smaller, ranging from 750 to 500 lb./sq. in. A. H. N.

113.* Slightly Less Drilling in 1941 Tentatively Indicated. Anon. *Oil Wkly*, 9.12.40, **100** (1), 38.—The tentative conclusion that a smaller number of wells will be drilled in 1941 than was accomplished in 1940 is based on information supplied by a group of oil companies, limited in number, yet constituting a fairly good cross-section of the industry.

The causes are briefly analysed. A. H. N.

114.* Recent Advances in Illinois Drilling Practices. B. De Laat. *Oil Gas J.*, 5.12.40, **39** (30), 45.—Drilling conditions in Illinois are distinctly different from those in most other fields in the U.S.A. The interval drilled by each bit rarely exceeds 300 ft. Thus, apart from the use of a great number of bits, drilling time is adversely affected. A simple apparatus which has been found useful in giving an index to the efficiency of drilling consists of industrial speed-indicating devices and revolutions counters. This equipment yields information concerning the number of revolutions of the bit needed to penetrate the various formations. From these data, the penetration index is obtained, which is the number of ft. cut/1000 revolutions of the rotary table, and appears to be an absolute term. Influence of various factors on drilling time is being studied individually.

If the weight on the bit can be kept in the neighbourhood of 3000 lb./sq. in. of bit, it has been found that drilling rates are greatly increased. In certain formations, doubling the weight increases the rate by 400%. Multiple or tandem drill-collars are used in experiments to increase drilling rates.

Mud problems peculiar to Illinois fields arise from the need to maintain delicate hydrostatic balance if loss of circulation is to be avoided.

Slim-hole drilling is reviewed. A. H. N.

115.* Applying Tool-Joints to Pipe at Remote Locations. N. Williams. *Oil Gas J.*, 12.12.40, **39** (31), 34.—Because of the advantages of being able to replace worn tool joints in the field, oil operators and manufacturers are developing tool joints which

are not only simple in their application in the field, but also eliminate the chances of improper fitting which always exist when no mill or machine-shop facilities can be used

"Shrink thread" or "Shrink grip" joints are described which can be installed without the use of bucking-on machines. The joint is designed with an extra length of gripping surface to provide a greater bond with the pipe and further relieve the strain on the threads; it also contains an inner seal that fits against the end of the pipe. The latter not only serves as a fluid seal, but also as a definite reference mark in sizing the tool-joints. The tool-joint is screwed on until the shoulder hits the end of the pipe, this being the only position in which it fits.

As a result of these developments in design of tool-joints, their replacement has resolved itself mainly into a mechanical problem of cutting off the old tool-joints and screwing on the new.

Details of the operations involved in cutting the old tool-joint, straightening pipe, lubricating the threads, and screwing on the new joint are given in full.

A. H. N.

116.* Determining Properties of Rotary Drilling Fluids. H. F. Simons. *Oil Gas J.*, 12.12.40, **39** (31), 36.—Note is taken of the lack of instrumentation on most drilling rigs and consequent lack of control and efficient handling of mud. Where instruments of simple types are found, these are often used incorrectly and the results become unimportant and devoid of potential correlation and value.

The characteristics of the muds to be determined are density, viscosity, wall-building properties, thixotropy, p_H values, sand content, salinity, and particle size. Instruments and procedures for the determination of these properties are described, the determination of density, viscosity, and wall-building properties being studied in greater detail than the rest.

The correct use of the hydrometer, Marsh funnel, and Stormer viscometer is emphasized by quoting several instances and methods of abusing these instruments or following wrong procedures. No theoretical or analytical treatment is presented, as the paper deals primarily with the practical aspect of manipulating these instruments.

A. H. N.

117.* Evaluation of Rotary Drilling Lines. H. C. H. Darley. *J. Inst. Petrol.*, August 1940, **26** (202), 407–412.—A formula is derived for the work done, in ton-miles, by a drilling line per round trip in the rotary drilling system, and the formula is compared with the Hallam Anderson's formula as given by Saatjian and Mason and approved by the American Petroleum Institute. Readings made from the alignment chart of Saatjian and Mason are, on a broad average, 50% higher than those obtained from the author's curve. A. H. N.

118.* Control of Drilling Mud in the Field. H. C. H. Darley. *J. Inst. Petrol.*, October 1940, **26** (204), 457–474.—A study of the more fundamental properties of mud fluids is made and experiments are described to be carried out in the laboratory or in the field in order to control these properties and maintain them within the range in which they are of greatest use and importance. A. H. N.

119.* Further Investigations of the Properties of Clay Suspensions. G. D. Hobson. *J. Inst. Petrol.*, December 1940, **26** (206), 533–564.—The investigations deal with experiments on clay in connection with flow properties as exhibited by capillary and modified rotary viscometers. An interesting saw-tooth curve is obtained with the latter instrument when torque is plotted against angle of rotation. Correlations with results of other experimenters are made throughout the paper. A. H. N.

120. Patents on Drilling. D. Scaramucci. U.S.P. 2,223,388, 3.12.40. Appl. 28.10.39. Cementing head with a chamber adapted to receive the lower of two cementing plugs.

R. Schaedler. U.S.P. 2,223,389, 3.12.40. Appl. 20.9.39. Guy wire fastener.

W. Bendeler and P. Howard. U.S.P. 2,223,439, 3.12.40. Appl. 11.4.40. Well perforator using a cutter actuated by a cam.

E. V. Crowell. U.S.P. 2,223,442, 3.12.40. Appl. 14.8.39. Apparatus and method of cementing wells using cement discharge ports which may be opened to allow passage of successive volumes of cement.

L. F. Brauer. U.S.P. 2,223,509, 3.12.40. Appl. 24.5.39. Float-valve for use in a drill pipe assembly.

C. White and O. B. Graham. U.S.P. 2,223,651, 3.12.40. Appl. 1.8.40. Slush-pump valve.

R. R. Bloss. U.S.P. 2,223,779, 3.12.40. Appl. 24.5.40. Rotary drilling machine.

Hijman Lumberg. U.S.P. 2,223,789, 3.12.40. Appl. 3.1.39. Process for sealing water-bearing strata, using a solution of asphalt bitumen in an organic water-miscible solvent, and precipitating the asphalt by dilution with water.

H. T. Kennedy. U.S.P. 2,223,804, 3.12.40. Appl. 4.11.38. Method of sealing pervious strata in oil or gas wells.

R. A. Wilson. U.S.P. 2,223,839, 3.12.40. Appl. 30.9.38. Valve-in-head packer

W. L. Church. U.S.P. 2,223,984, 3.12.40. Appl. 16.11.39. Outside pipe cutter.

S. P. Hart. U.S.P. 2,224,120, 3.12.40. Appl. 21.7.38. Treatment of oil wells, for recovering lost circulation during drilling, with a casein plastic containing more than 5% by weight of casein. A. H. N.

See also Abstract No. 213.

Production.

121.* Phase Behaviour in the Methane–Propane–*n*-Pentane System. R. T. Carter, B. H. Sage, and W. N. Lacey. *Petrol. Tech.*, November 1940, A.I.M.M.E. Tech. Pub. No. 1250, 1–8.—The method of examining the phase behaviour of the methane–propane-*n*-pentane system is briefly described, and its limitations are indicated. The results obtained show that at 100° F. the critical pressures of the ternary mixtures are less than the critical pressure of the binary mixture the components of which exhibit the maximum divergence in critical temperature. However, the experimental work was not sufficiently complete to establish the critical behaviour with great accuracy, and it is possible that a small maximum might exist in the ternary region in the immediate vicinity of the methane-*n*-pentane axis. The measurements indicate a marked influence of the nature and amount of other components on the phase behaviour of these lighter paraffin hydrocarbons. These effects are appreciable in propane and *n*-pentane at a pressure of 500 lb./in.², and pervade the entire two-phase region for methane. This feature limits the usefulness of the equilibrium constants, for they are a function of the heterogeneous system rather than a quantity that is a function only of pressure and temperature. At pressures in excess of 1000 lb./in.² the variations are such as to render the prediction of the phase behaviour of systems of this nature, from generalizations based alone on variations in pressure and temperature, of little avail. G. D. H.

122.* Volumetric Behaviour of Oil and Gas from the Rio Bravo Field. B. H. Sage and H. H. Reamer. *Petrol. Tech.*, November 1940, A.I.M.M.E. Tech. Pub. No. 1251, 1–12.—Samples of the gaseous and liquid phases of a field with a reservoir pressure of 4500 lb./in.² and temperature of 250° F. were obtained from a production trap, and their volumetric behaviour and that of eight mixtures of the two was determined for pressures up to 5000 lb./in.², and temperatures from 100° to 250° F. Data about the chemical constitution and physical properties of the trap samples are given.

Tables give the compressibility factors for the gas sample, the specific volumes of the trap liquid sample, and the composition, specific volumes, and formation volumes of mixtures of the trap samples. Curves show the compressibility factor for the trap-gas sample, the specific volume of the trap-liquid sample near the bubble point, the effect of gas/oil ratio on formation volume and on bubble-point pressures.

An equation is given which approximately relates the formation volume of a heterogeneous mixture and the behaviour of the bubble-point liquid and the trap-gas sample.
G. D. H.

123.* Equilibrium Constants for Hydrocarbons in Absorption Oil. C. E. Webber. *Petrol. Tech.*, November 1940, A.I.M.M.E. Tech. Pub. No. 1252, 1–11.—The absorption oil was a straw-coloured, steam-distilled oil of an initial boiling point of 300° F. *n*-Hexane, propane, *iso*butane, *n*-butane, *iso*pentane, *n*-pentane, ethane, and methane were the light hydrocarbons used. The apparatus in which equilibrium between the hydrocarbons methane to hexane and natural gas and a typical absorber oil for temperatures of 33–180° F. and pressures of 100–5000 lb./in.² was determined, is described in detail, together with the experimental technique. The analytical results are tabulated, and the equilibrium constants are plotted against the pressure for temperatures of 100° and 180° F. Each of the K-value curves for all the hydrocarbons heavier than methane was found to pass through a minimum, and thereafter increase rapidly with increasing pressure. The pressures at the minimum K-values varied with the temperatures and for the different components, being lower for the heavier components. At the higher pressures the K-values for all the components approached unity, but there was a significant reduction in the rate of approach at 5000 lb./in.².

The K-values seem suitable for any multi-component hydrocarbon system up to 1500 lb./in.². Above 3000 lb./in.², the composition of the mixtures has a pronounced effect, and care must be exercised in applying these values to systems that differ considerably from that investigated. Absorber operations seem feasible, even above 2000 lb./in.², the optimum point with regard to oil circulation being at the pressure where the K-values are at a minimum for the given temperature. G. D. H.

124.* Study of Well Spacing, Sinclair–Moren Pool, Young County, Texas. M. G. Cheney. *Petrol. Tech.*, November 1940, A.I.M.M.E. Tech. Pub. No. 1253, 1–4.—The producing record of the Sinclair–Moren pool shows that under efficient operating conditions a single well may obtain normal oil recovery from an area of 100 acres or more, and this was where water drive was lacking, initial reservoir pressure only moderate, and the consolidated sandstone reservoir had an original permeability greatly reduced by lithefaction. The well penetrated the sand from 2512 to 2559 ft., and initially gave 12,000,000 cu. ft. of gas and 1100 brl. of oil/day. Two other wells did not find the sand, and a third was a poor producer. Ten years later the well had given 1,160,000 brl. of oil and was still giving 90 brl./day at 120 lb./in.². The drilling-in evidence is against its being a crevice well, and its good production was apparently due to the absence of nearby competitive wells for over ten years, to gas conservation by efficient production methods, and perhaps to the presence of 50 ft. of oil sand. At this time further wells were drilled which had good outputs. From a consideration of sand thickness and the well's output, this first well seems to have been draining about 100 acres effectively. Its gas/oil ratio was cut back strongly soon after its completion.

The record of this lease appears to demonstrate that the withdrawal of oil through closely spaced reservoir outlets has been at the expense of producing efficiency.
G. D. H.

125.* Some Factors Influencing Recovery of Condensate in Recycling Operations. L. S. Reid. *Petrol. Tech.*, November 1940, A.I.M.M.E. Tech. Pub. No. 1259, 1–6.—The operator of every gas-recycling project is faced with two problems: (*a*) To remove a maximum quantity of the desirable hydrocarbons from the reservoir fluid, and (*b*) to return the residual gas to the producing formation with the least possible expenditure of compressor horse-power. Some projects have given excellent recoveries whilst operating at compression ratios within the limits of good practice, but the continued discovery of gas condensate production at pressures of 3000–6000 lb./in.² calls for improvements on the present processes.

The low-temperature condensation process using chilling to 0° F. has given 90% efficiency when operating on gas of relatively low condensate content at a pressure of about 300 lb./in.² greater than the observed maximum condensation pressure, but there are indications of a reversal of the isotherm positions at high pressures which

would apparently render low-temperature condensation processes relatively ineffective at extremely high pressures. This is especially true for gases of low condensate content.

A commercial absorption plant working at 1200 lb./in.^{2} has been successfully operated with an efficiency of 98%. The absorption oil must be carefully controlled, and differs considerably from the conventional low-pressure absorption oils. Oil circulation rate is important.

A discussion of the paper by K. Eilerts is included. G. D. H.

126.* Methods of Interpreting the Findings in Core Analysis Work. F. Hornkohl. *Petrol. Eng.*, December 1940, **12** (3) 46.—After cleaning the outside of the core which is likely to be mud-contaminated, the degree of cementation, grain size and shape, and bedding are noted. The oil and water content is determined by distilling 100–150 gm. of the crushed sand. The minimum oil saturation so determined for such a sample to have commercial production at a certain depth is tabulated. The quartz lamp gives a marked fluorescence in the presence of light petroleums which might not colour extracting solvents, but not with mere gas sands. Connate water may be 30–70% of the total saturation, and is higher the lower the permeability of the sand. The sample for this measurement must be taken from the centre of a large core so that it will not be affected by drilling mud water, and the same is true for the salinity measurements

The permeability is measured along and perpendicular to the bedding, and the same specimen is used for the porosity determination. These two factors enable estimates of the storage capacity and the probable productivity of the reservoir rock to be made.

Grain-size analyses are useful for fixing the size of liner slots. The oil gravity in the reservoir can be estimated from the gravity of that distilled from the core.

G. D. H.

127.* Principles of Allocation in Oil Conservation. J. E. Pogue. *Oil Wkly*, 9.12.40, **100** (1), 12–15. Cf. *Oil Gas J.*, 12.12.40, **39** (31), 19.—The present system is outlined and explained and suggestions are made to modify it. The principles and procedures involved in the new system for conservation are :

Proration should be based on conservation, with equity and equilibrium as subordinate but essential supports. The central principle of conservation is the optimum rate of production, and this engineering criterion should gradually supersede economic criteria to the fullest extent possible in the techniques of allocating market demands. The maintenance of equity and equilibrium requires that changes in established practices shall be graduated transitions.

Forecasts of the total market demand by the U.S. Bureau of Mines should be founded on the broad base of total demand for all oils and recommendations made to the States by grades of crude. The allocations of total market demand to States, as now done on the trade channel procedure, is workable, but the optimum rate factor should be gradually accorded weight in the formula. State allowables should be broken down to regional quotas to serve as the basis for computing field allowables. Field allowables should be derived from the regional allowables and established on a basis gradually shifting to a common ratio to optimum rates.

The evolution away from the well as the unit of proration within the individual field should be encouraged in favour of the developed reserve as a function of the optimum rate. The developed reserve should be used in place of optimum rates for one or two years if necessary. A. H. N.

128.* Prevention of Flood Delays. Anon. *Oil Wkly*, 9.12.40, **100** (1), 16.—Methods to be followed in preventing delay of production by floods are described, and these consist of various simple and elaborate precautions, ranging from building earth mounds around the well to substantial reinforced-concrete constructions. Certain wells have been protected from heavy driftwood by erecting triangular cages of tubular steel around the Christmas tree, which cages will permit uninterrupted flow of water past the well, but will divert any heavy driftwood.

Temporary measures are also described in which use is made of sandbags, twig mattresses, and current chokes made of junk automobile bodies either weighted down

by filling with earth or anchored by pipes to the soil. These measures are useful where floods usually take a few days before they assume serious proportions, and thus can be guarded against in time. A. H. N.

129.* Patents on Production. L. A. Layne. U.S.P. 2,223,374, 3.12.40. Appl. 30.9.38. Apparatus and method of gravelling wells, using two strainers of different meshes, one to exclude the oil sand but not the gravel, and the other to exclude both.

R. L. White and O. W. Lyons. U.S.P. 2,223,397, 3.12.40. Appl. 18.4.38. Treatment of wells with acid and using an aqueous dispersion of an organic jellifying material to protect permeable strata which are not to be acid-treated.

A. L. Cox. U.S.P. 2,223,602, 3.12.40. Appl. 4.10.38. Sand sucker apparatus for use in oil wells.

A. J. Penick and K. T. Penick. U.S.P. 2,223,702, 3.12.40. Appl. 28.3.38. Pressure control tubing-head with a valve controlled from outside.

H. Hügel. U.S.P. 2,223,786, 3.12.40. Appl. 13.1.38. Borehole pressure-gauge with a marking instrument mounted for rotary and reciprocating movements.

R. A. Gulick. U.S.P. 2,223,869, 3.12.40. Appl. 25.11.39. Pumping assembly.

J. L. Johnston. U.S.P. 2,223,913, 3.12.40. Appl. 4.9.37. Oil pressure tester with a timing mechanism to give a time-measured graph of pressure on a chart.

A. D. Garrison. U.S.P. 2,223,933, 3.12.40. Appl. 10.6.38. Treatment of oil wells to increase the proportion of oil relative to water produced by converting a water-wet producing sand to one which is preferentially wettable by oil, by depositing on the sand, without blocking, a film of water- and oil-insoluble metallic sulphide.

S. P. Hart. U.S.P. 2,223,936, 3.12.40. Appl. 16.2.40. Device for depositing chemicals of two different natures in a well simultaneously. A. H. N.

Transport and Storage.

130.* Methods of Studying Microbiological Anærobic Corrosion of Pipe-lines. R. F. Hadley. Part I. *Petrol. Engr*, March 1940, **11** (6), 171, and Part 2, *Petrol. Engr*, April 1940, **11** (7) 112.—In order to direct attention to the seriousness and widespread occurrence of corrosion by anærobic sulphate-reducing bacteria, a review is presented of the factors controlling this type of corrosion, methods of identification of its presence, and means of pipe protection against it. An examination of over 1500 test holes in pipe-lines in 16 counties in the eastern States revealed that from 6·7% to 72·9% of the test holes in each country were undergoing bacterial attack and that a high proportion of the pipe required protection against this corrosion. The HCl test for ferrous sulphide previously recommended for the detection of microbiological anærobic corrosion by the author (*Oil Gas J.*, 21.9.39, p. 92) has been criticized, but in every case where positive results have been given by it, or by laboratory analysis, cultures of sulphate-reducing bacteria have been grown from the location. It has also been proved that the sulphur present in the steel is insufficient to account for the sulphur found in the corrosion products. It is recommended that the ferrous sulphide test be checked by attempting to grow the bacteria (*Sporovibrio desulphuricans*) from its corrosion products, since the conditions under which bacterial corrosion and long-circuit differential æration corrosion proceed are identical and often found together. It is believed that the extent of pipe undergoing bacterial corrosion can be correlated with the degree of anærobiosis present. The factors affecting the development of microbiological corrosion include the degree of anærobiosis, the p_H of the soil water and the presence of a sulphur-oxygen salt. A number of organic compounds have been found to be available as hydrogen donators to certain strains of sulphate-reducing bacteria. Compounds formed in nature from sewage or cellulose, etc., decomposition or fermentation may give rise to conditions favourable for sulphate-reducing bacteria, so that the presence of wooden skids, tree trunks, vegetation, etc., in a pipe trench may give rise to corrosion by this means.

The p_H value is useful in determining the likelihood of serious bacterial corrosion, whilst SO_4 and CO_2 determinations have so far shown little correlation.

With regard to the life of pipe-line, it has been found that the rate of corrosion increases with time, probably owing to the fact that products of corrosion are maintained in the ferrous state and are not precipitated as impermeable membranes of ferric hydroxide. There is at present insufficient evidence on the value of cathodic protection currents against bacterial corrosion. Use is being made of petroleum asphalt coatings encased in a box of durable wood. C. L. G.

Crude Oil.

131.* Removal of Inorganic Salts from Petroleum. C. M. Blair, Jr. *Refiner*, April 1940, **19** (4), 107–110.—The presence of inorganic salt in crude oil leads to two principal troubles—namely, stoppage of flow or decreased throughput, and corrosion. These, in turn, lead to accelerated coke formation, decreased heat transfer, increased replacement costs, lengthened shut-down time, increased labour requirements and lowered quality of products.

The presence of inorganic salts in crude oils almost invariably means that the oil contains emulsified brine—or, as it is frequently called, "BS." Examination of "BS" under the microscope reveals that it consists of minute droplets of a liquid dispersed in a continuous phase of oil. The dispersed liquid is water or an aqueous solution of salts. Cases have been reported where actual microscopic, cubical crystals of NaCl may be seen dispersed in the oil. The occurrence of solid salt dispersed in crude oil is, however, rare. Where solid salt is found in crude oil, it is often due to some treatment received by the oil after its production. Solid salts sometimes result from the evaporation of water from an emulsion which originally contained a concentrated brine. High-temperature field treating is often responsible for the occurrence of solid salt in oil.

Mechanical methods of desalting involve sedimentation or filtration and the paper briefly describes these. However, the chemical methods used to remove these inorganic constituents represent the major section of the paper.

In an average or typical plant, demulsifier is mixed with crude at the charge pump; fresh water is introduced after the oil has been heated through the first exchanger. The water is dispersed in the oil by passing the mixture through a globe valve, giving a pressure drop of 10–15 lb. The mixture then passes through another exchanger and goes into a settling drum having a capacity sufficient to give 1½ hrs. settling time. Water is drawn continuously from this drum, and clean, desalted oil leaves at the top.

The chemical desalting method has definitely established itself as a successful commercial method. As shown by the examples given, the amount of demulsifier required varies with the type of oil, the salt content, and manner in which the reagent is used. It is emphasized that the use of a chemical reagent is not alone sufficient for successful removal of salt or brine from crude oil. It must be selected and employed in the proper manner, and its action must be complemented by the installation and operation of a properly designed system. A. H. N.

132. Aid in Interpreting Crude-Oil Analyses. H. M. Smith. U.S. Dept. of the Interior, Bur. Mines, Technical Paper 610, 1940.—The author of this paper suggests a means whereby analyses of crude oils may be extended to emphasize not only similarities between a number of samples, but equally important differences not usually directly apparent as a result of such analyses. Using boiling-point and specific-gravity values as a basis, an index number can be found, the magnitude of which indicates certain characteristics of a crude-oil distillation fraction.

Thus, a fraction composed exclusively of normal paraffin hydrocarbons would have zero as its index number, a fraction from a paraffin base crude oil of the usual type would have a small index-number, and fractions from intermediate naphthene-base crude oils increasingly high index-number values.

The actual equation which has been developed for calculating the correlation index of a fraction is as follows :—

$$\text{C.I.} = \frac{48640}{K} + 473{\cdot}7\,G - 456{\cdot}8$$

where C.I. is the correlation index, K the average boiling point of the fraction in degrees Kelvin (degrees Centrigrade plus 273), and G is the specific gravity of the fraction at 60° F./60° F.

Use of this correlation index should provide a useful alternative to the "base" system of classification of crude oils which is frequently ambiguous. For instance, naphthene-base oils, in addition to naphthenes may contain asphaltic material which is not naphthenic, aromatic hydrocarbons, and even paraffin wax. The correlation index does not have the effect of grouping together crude oils in accordance with their properties. It gives direct information concerning the distillable portion of a crude oil. In this way defects of the "base" system of classification are eliminated; differences as well as similarities can be assessed, and there are no doubtful cases of classification.

H. B. M.

Gas.

133.* Elimination of Hydrate Troubles. E. G. Hammerschmidt. *Refiner*, June 1940, **19** (6), 215–218.—Nearly all freezing troubles in natural-gas pressure systems are caused partly or entirely by hydrocarbon hydrates, crystalline chemical compounds of methane, ethane, propane, or *iso*butane in which water is present in simple molecular proportions. The trouble may be permanently removed by lowering the dew point of the gas to the minimum temperature of the system when operating at maximum pressure, *i.e.*, by partial dehydration.

The magnitude of the lowering of dew point which may be effected by any aqueous hygroscopic solution is a function of the nature of the material and the contact temperature, whilst the residual water-vapour content of the gas is also a function of the total pressure of the systems. Charts and tables are presented detailing the characteristics of various dehumidifiers, and a detailed discussion illustrates their significance in typical plant operations.

Solid drying agents may be used for practically complete removal of water from the system. The relatively small quantities necessary for treatment of high-pressure gas makes possible an economical design of a dehydration plant using solid agents. Where complete dehydration is not necessary, a part of the gas may be completely dried, and then mixed with the wet gas by-passing the unit, thus increasing the capacity of the plant. The operating characteristics of a silica gel adsorbent plant are briefly given.

A. H. N.

134.* Modern Practices in the Dehydration of Natural Gas. T. S. Bacon. *Petrol. Engr*, Midyear 1940, **11** (10), 82.—Greater use of natural gas dehydration methods is due to the increasing use of higher operating pressures on transmission lines (up to 3000 lb. per sq. in.), to the availability of more exact information on the effects of pressure on hydrate formation, and to reduction in dehydration costs resulting from technical improvements in processes. The effect of an increase in temperature is to increase the temperature at which hydrates will form—*e.g.*, natural gas from the Texas Panhandle field is subject to freezing at 35° F. if the pressure is 125 lb. per sq. in., but at 52° F. if the pressure is 500 lb. per sq. in. Dehydration processes are of four main types: (1) Refrigeration to condense water vapour. (2) Absorption of water vapour in inorganic brines—*e.g.*, $CaCl_2$. (3) Absorption in liquid organic chemicals—*e.g.*, diethylene glycol. (4) Adsorption on solid materials—*e.g.*, activated alumina.

(1) Refrigeration causes partial dehydration if the dew point of the gas is above the temperature at which the gas leaves the coolers, but is limited by the formation of hydrates, causing plugging, if operation is below this temperature.

(2) Absorption in $CaCl_2$ solution is widely used, the solution being cheap, stable, and fairly effective, but tending to become corrosive and to solidify on cooling or concentration. The maximum dew-point depression obtainable is less than 30° F., actual figures being 20–25° F. Improved results are given by combining the plants with refrigeration units.

(3) Absorption in glycerine is seldom used owing to its cost and instability, although giving a greater dew-point reduction than $CaCl_2$ solution. Diethylene glycol gives a dew-point depression of 45° F., is non-corrosive, and does not solidify. It was used in 16 plants in 1939, and is useful in combination with amines for sour gases.

(4) Solid adsorbents—activated alumina and silica gel—can dehydrate gas almost completely, the former being in commercial use. Anhydrous calcium sulphate and solid calcium chloride are also used as absorbents.

Type 1 plants are the cheapest to operate, type 3 being slighty dearer than type 2, although causing less trouble and being more efficient. Operating costs on types 2 and 3 plants vary from 7 to 75 cents per million cu. ft. of gas. Selection of the most suitable type of plant must take into account the dew-point depression obtained and plant location (*i.e.*, using a single large plant or a number of smaller plants). In view of the high pressures in field lines, there is a considerable field of application for small self-contained fully automatic dehydration plants for well-head use.

C. L. G.

Cracking.

135.* Houdry Catalytic Process. O. W. Wilcox. *World Petrol.*, October 1939, **10** (11), 51.—The Houdry process is based on three groups of interrelated inventions viz.: (1) the catalyst; (2) the catalyst cases for contacting the feed-stock with the catalyst; (3) the methods by which the reactions are controlled.

The catalysts consist of natural or prepared clays, the effectiveness of which may be supplemented or modified by the addition of metals or metallic oxides. The catalysts are prepared in granular form, the treatment being controlled to give the required activity.

Regeneration is effected by burning off deposited carbon in a stream of air, and a feature of the catalysts is freedom from loss of activity when subjected to the heat treatment necessary for regeneration. Catalyst masses are stated to have withstood thousands of regenerations without serious depreciation.

The catalyst cases have to withstand severe conditions, in that there is frequent alternation between on-steam operation at about 840° F. and catalyst regeneration at about 950° F. Heat transference is accomplished by a circulating system in the cases, and the whole apparatus is designed to effect exchange of heat as rapidly as possible.

A considerable number of variables in the process—*e.g.*, pressure, temperature, time of reaction, etc.—are under accurate control. This makes the process flexible, in that the products from a given raw material may be controlled to meet specific requirements. The adaptability of the process has made possible the transformation of residues.

Notable results of Houdry cracking are: (1) high yield of gasoline; 44–46% of charge; (2) high octane rating of the gasoline; and (3) high recovery; in many cases the volume of gasoline and gas oil produce is almost equal to the charge. The quality of the products is claimed to represent a distinct advance over thermally cracked products.

Data on a Houdry plant processing 13,000 brl. per day show an operating cost of 6–8 c. per brl., as compared with 12–14 c. estimated for thermal cracking. Moreover, a greater appreciation in the value of the products is claimed for Houdry cracking as compared with thermal cracking.

Comprehensive data on the results of catalytic cracking operations are included, and a detailed description of a Houdry plant operating at Marcus Hook is given.

R. J. E.

136.* Era of Catalytic Cracking. M. B. Cooke. *World Petrol.*, October 1939, **10** (11), 72.—The development of catalytic cracking is associated with the increasing demand for high-octane aviation fuels. The development in recent years of high-octane gasoline producing plants is reviewed. The processes reviewed include:—

1. Re-forming of naphtha. The relative merits of reforming cum polymerization and naphtha reversion are discussed.
2. Polymerization of unsaturated gases and pyrolysis of saturated gases.
3. Production of *iso*-octanes by polymerization and hydrogenation and by alkylation.
4. Production of aromatics from petroleum gases by pyrolysis.
5. Catalytic cracking and catalytic reforming.

The merits of the various processes from a consideration of the raw material used and its availability, and the yield and quality of the products are reviewed.
R. J. E.

137. Patent on Cracking. M. Pier and W. Simon. U.S.P. 2,224,003, 3.12.40. Appl. 24.3.39. An initially highly active catalyst, the activity of which has been reduced by its employment in a pressure hydrogenation treatment of carbonaceous substances poor in hydrogen, is used in the cracking of hydrocarbons containing more than 15 gm. of hydrogen per 100 gm. of carbon. H. B. M.

Polymerization.

138.* Thermal Reforming Plus Catalytic Polymerization. R. P. Mase and N. C. Turner. *Refiner*, April 1940, **19** (4), 111–112.—By combining thermal reforming with catalytic polymerization, a definite improvement is made, first, in reduction of losses, and, second, in increase in octane number, as compared to the results of straight reforming. From a plot of experimental data it is apparent that thermal reforming alone will produce a 70-motor-method octane product with an 80% yield of product, based on feed volume, whilst with catalytic polymerization added, a 70-motor-method octane can be produced with 85% yield of product. In short, on an equivalent octane basis, a 5% increase in yield, on an equivalent 70 octane is had by adding polymerization, or, conversely, the loss is cut by 5%. On the basis of an equivalent yield of, say, 85%, the octane may be increased by 2·5 points, with the addition of polymerization.
A. H. N.

139.* Induced Pyrolysis of Methane. W. J. Hessels, D. W. van Krevelen, and H. I. Waterman. *Refiner*, April 1940, **19** (4), 127–130.—In the pyrolysis of methane the primary change is the formation of radicals which react with each other and with the undecomposed methane molecules.

The same radicals can also be formed by the chemical action of, *e.g.*, halogenes on methane or by the thermal decomposition of aliphatic hydrocarbon groups which are less stable than methane itself. Hydrocarbons, especially aliphatic hydrocarbons, such as propane, butane, etc., and hydrocarbon derivatives such as halogen and sulphur compounds and oxygen compounds, which are able to split off hydrocarbon radicals, can be used for the production of the radicals necessary to demonstrate the induction effect on the methane pyrolysis.

The inductor effect has been shown without any ambiguity by experiments with pure methane under comparable conditions, and also by experiments with the inductor in a pure state in a nitrogen medium.

By applying the inductor effect of foreign substances it has been shown that methane can be transformed into unsaturated hydrocarbons (ethylene, acetylene, benzene, naphthalene) under such conditions that methane alone passes the heating zone unchanged.

The ratio of methane to inductor in the ingoing gas mixture is of importance. The inductor effect is more marked if the concentration of the inductor molecules is smaller compared with the methane concentration.

Aliphatic molecule structures are essential for the inductor action; aromatic compounds such as benzene and naphthalene had very little or no induction effect on the methane pyrolysis in the authors' experiments.

High-percentage conversions of methane are observed when the gases are passed through the furnace several times. Unsaturated aliphatic gases formed in the first passage through the heated tube act as inductor in the next passage.

Induced pyrolysis can be applied to methane present in natural gases. These gases contain, in addition to methane, substances capable of acting as inductors.

It has been shown that by the decomposition of the higher hydrocarbons present in natural gas, methane can partly be involved in the decomposition under conditions in which pure methane undergoes no decomposition. A. H. N.

140.* Gulf Polyform Process. P. Ostergaard and E. R. Smoley. *Refiner*, September 1940, **19** (9), 301–312.—The Polyform process differs from the ordinary thermal

cracking process in that the oil is processed in admixture with varying amounts of normally gaseous hydrocarbons, particularly propanes and butanes, and in that the oil is subjected to higher temperatures and higher degrees of conversion/pass than would be possible, under otherwise similar conditions, without excessive coke formation in the cracking tubes. The process results in higher yields of gasoline of higher octane rating than can be obtained by subjecting the same oil to conventional thermal cracking operation.

In discussing the theory of the process in some detail, it is pointed out that any process by which crack/pass can be increased means higher octanes and greater yields of light products. The gasoline yield can be further increased by converting part of the gases produced into gasoline hydrocarbons. The gaseous hydrocarbons are introduced into the oil in the coils in order to effect a higher degree of conversion of the oil when diluted with C_3 and C_4 hydrocarbons than is possible without the use of C_3 and C_4 gases; and, further, to effect side reactions and polymerizations with the C_3 and C_4 themselves. The temperature of the mixture must be above the critical temperature so that a solitary homogeneous gaseous phase results in the coil, thus obviating the settling of a liquid film on the coil with many resultant bad effects on the yield and quality of the products. This subject is discussed in detail.

Flowsheets and descriptions of typical Polyform plants are given with data on yields and qualities of products obtained from various crudes.

The octane number of Polyform gasoline depends, like the numbers of all other cracked gasolines, on the characteristics of the charging stocks. Naphthenic stocks, in general, yield gasolines of the highest C.F.R.–A.S.T.M. octane numbers obtainable by this process, whilst the paraffinic stocks yield the lowest numbers. However, in Polyform cracking, it is always possible to produce gasoline with an octane number of 75 to 77, regardless of the characteristics of the charging stock. Illustrations of these facts are given.

Polyform gasoline is characterized by having a very much higher appreciation between C.F.R.–A.S.T.M. octane ratings and C.F.R.-Research octane ratings than ordinary thermally-cracked gasoline. Treating Polyform gasoline for motor and aviation petrol production is discussed. A. H. N.

141. Some New Developments in the Petroleum Industry. W. D. Williams. *Chem. and Ind.*, 1941, **60**, 22–24.—The outstanding developments in the petroleum industry over the last few years have been due to the efforts to increase the octane numbers of motor spirit. Between 1931 and 1939 average octane numbers of first-grade motor spirit rose from 60 to 74. The various steps to obtain the higher-performance fuels are reviewed.

Thermal and catalytic polymerization of refinery gases are capable of very great potential development. It is estimated that 3000 billion cub. ft. of the necessary gases are produced annually and that such a quantity could be converted to 1500 million gallons of motor spirit.

The catalytic polymerization is much more productive than the thermal process—*e.g.*, average yields of the former are 8·3 gal. per 1000 cub. ft. and of the latter 3·7 gal. per 1000 cub. ft.

The Houdry catalytic cracking process has been developed to avoid the more drastic thermal cracking. The process is said to convert 85% of the charging stock to motor spirit with an octane number of 78–80.

The developments of polymerization and alkylation have resulted in, for instance, *iso*-octane now being produced in vast quantities at one hundredth its cost in 1930 (when it was £6 per gallon). Further, these developments have led to plants being contemplated for the manufacture of 150 Octane No. fuels.

The use of refinery gas as a raw material for the manufacture of a wide series of chemicals is reviewed. These chemicals include many alcohols, ketones, ethers, and ethylene glycol. The production of cheap acetylene by submitting refinery gas to the electric arc has led to the development of the chlorinated acetylene group of solvents, of neoprene and the vinyl resin group of plastics.

Short notes appear on the solvent refining of lube. oils and on the production of synthetic rubbers. T. C. G. T.

142.* Applications of Thermal Polymerization. Humble Oil & Refining Co., Phillips Petroleum Co., and the M. W. Kellogg Co. *Oil Gas J.*, 22.6.39, **38** (6), 52. *Paper presented before 1939 annual meeting N.G.A.A., Tulsa.*—A comprehensive discussion is given of the design, operation, and economics of thermal polymerization plants based on the results obtained from two plants in operation. Five different flow-sheets are compared and analysed and the effect of various plant modifications discussed. The relative values of paraffin hydrocarbons as polymerization feed-stocks are compared, and a suggested design given for thermal polymerization, to be used on natural gasoline plants.

The two plants described are : (*a*) a polymerization unit at a Baytown Tex. refinery of capacity 8000 bbl. per day liquid butane with a complete propane-recovery system, producing light and heavy polymer gasoline streams, and (*b*) a smaller unit at a Borger Tex. refinery of capacity 2500 bbl. per day, in which complete propane recovery is not attempted, and producing one polymer-stream which is vapour-phase clay treated. For commercial operation on paraffin hydrocarbons, *n*-butane is the most valuable, *iso*butane next, and propane third, ethane being of little value. Under the same conditions of pressure, but increasing the crack per pass, the ultimate yield of polymer decreases, and does not allow of long runs. On the other hand, with a smaller crack per pass, a larger-sized furnace, stabilizing unit and recovery system are required. In general, quenching is resorted to, where possible, in order to retard coke deposition and increase the length of run, so that polymerization units operating in connection with refineries (having quenching oils available) are designed to operate at a high crack per pass, whilst those in connection with casing-head plants are based on a low crack per pass. For processing propane a furnace soaking volume 3·83 times as great as that for butane is required. The economics of the two plants in question are finally discussed, direct comparison being difficult, owing to different methods of accounting and basic values. C. L. G.

143. Patents on Polymerization and Alkylation. Texaco Development Corp. E.P. 527,720, 15.10.40. Appl. 13.4.39. Alkylation of hydrocarbons by subjecting olefinic or olefine-containing hydrocarbons and *iso*paraffins or *iso*paraffin-containing hydrocarbons to the action of strong sulphuric acid in a reaction zone under alkylating conditions. In this way the *iso*paraffins are alkylated by the olefines to form saturated branched-chain hydrocarbons. Thereafter the reaction mixture is withdrawn and a portion thereof recyclized to maintain a higher ratio of acid and *iso*paraffins than was present in the initial mixture.

I.G. Farbenindustrie A.-G. E.P. 527,767, 16.10.40. Appl. 14.3.39. Process for the isomerization of paraffinic hydrocarbons having from four to twelve carbon atoms in the molecule. The hydrocarbons are passed at a temperature between 200° and 600° C. and at a pressure above 100 atmospheres, together with hydrogen having a partial pressure of less than 5% of the total pressure, over catalysts having an adsorbent or hydrogenating or dehydrogenating action.

N.V. De Bataafsche Petroleum Maatschappij. E.P. 527,805, 16.10.40. Appl. 20.4.39. Method of reducing the cost of polymerizing olefines by prolonging the life of polymerization catalysts. This is effected by washing the olefines with water prior to contacting them with the catalyst. The invention has particular reference to phosphoric acid catalysts, but is equally applicable to other phosphorus-containing catalysts, sulphuric acid polymerization catalysts, or non-acid catalysts known to be capable of polymerizing olefines.

Anglo-Iranian Oil Co., Ltd. E.P. 528,178, 24.10.40. Appl. 16.3.39. Use of anhydrous ferric chloride as a catalysis-promoter in the process of isomerization of normal paraffins.

Texaco Development Corp. E.P. 529,194, 15.11.40. Appl. 24.5.39. Alkylation of *iso*paraffins with olefines by treating the olefines and an excess of low-boiling *iso*paraffins with concentrated sulphuric acid under alkylating conditions. Thereafter the used acid is separated from the hydrocarbon reaction products and contacted separately with olefine-free *iso*paraffins to strip it of absorbed hydrocarbons.

Texaco Development Corp. E.P. 529,197, 15.11.40. Appl. 24.5.40. Alkylation of low-boiling *iso*paraffins with olefines by charging *iso*paraffins, olefines, and liquid

acid catalyst to a reaction zone at such a rate that a predetermined acid to hydrocarbon ratio is maintained in the fresh feeds to the zone. The acid and hydrocarbons are contacted in the zone to obtain alkylation of the *iso*paraffins by the olefines, and the hydrocarbon reaction products and acid thereafter withdrawn. Subsequently the acid and hydrocarbons are separated and the acid recyclized to the reaction zone in an amount sufficient to maintain a higher ratio of acid to hydrocarbons in the reaction zone than in the fresh feeds.

Texaco Development Corp. E.P. 530,250, 9.12.40. Appl. 31.5.39. Manufacture of motor fuels and production of hydrocarbons of gasoline boiling-point range by the alkylation of *iso*paraffins, such as *iso*butane, with normally gaseous olefines.

V. N. Ipatieff and A. V. Grosse. U.S.P. 2,217,019, 8.10.40. Appl. 28.2.38. Production of hydrocarbons boiling within the gasoline range by reacting *iso*butane with a normally gaseous olefin in the presence of boron fluoride, nickel, and hydrogen fluoride.

F. R. Moser. U.S.P. 2,218,135, 15.10.40. Appl. 16.5.34. Preparation of a liquid motor fuel having incorporated therein small quantities of methyl ethyl ketone peroxide.

C. A. Kraus. U.S.P. 2,220,930, 12.11.40. Appl. 3.11.38. Polymerization of hydrocarbons of the olefin series by contacting them with a compound of the formula $MXmRn$, where M represents a member of the class consisting of aluminium, gallium and boron, X represents a halogen, R a monovalent hydrocarbon radical, and m and n each represent an integer from 1 to 2, inclusive, $m + n = 3$.

W. E. Kuentzel. U.S.P. 2,221,000, 12.11.40. Appl. 11.8.37. Improvement in the process of polymerizing hydrocarbons containing *iso*butylene into resins in the presence of a catalyst.

A. Wassermann. U.S.P. 2,224,071, 3.12.40. Appl. 18.5.38. Treatment of olefin hydrocarbons with a combined catalyst consisting of a heavy metal sulphide and a heavy metal sulphate. The olefins and the catalyst are subjected to a temperature between 100° and 200° C. until a part of the olefins is converted into polymers the boiling point of which is at least 50° C. higher at atmospheric pressure than that of the original material.

M. M. Holm, E. H. Oakley, and R. L. Humphreys. U.S.P. 2,224,102, 3.12.40. Appl. 26.6.39. Alkylation of *iso*paraffins with olefins by contacting *iso*paraffin and olefin with sulphuric acid of alkylating concentration and maintaining the concentration of alkyl acid sulphate in the acid below about 1% by weight of the acid.

H. B. M.

Synthetic Products.

144. Synthesis of Petroleum-like Hydrocarbons from Carbonaceous Material. R. Fussteig. *Petrol. Engr*, May 1940, **11** (8), 95.—The development of water-gas manufacture as a source of gasoline is reviewed. Water-gas can be manufactured from a variety of solid and gaseous fuels: coke, various coals, wood, peat, natural gas, and coke-oven gas. In each case the composition of the water-gas depends on the operating conditions, a temperature of 1100–1200° C. being considered the most suitable to give a CO : H ratio of 2 : 1. The use of catalysts prevents the formation of carbon and promotes the decomposition of methane. A detailed description and flow-sheet of the manufacture of water-gas from coal are given. Steam is injected into the reaction chamber at the moment when the coal decomposes into gases and coke. Reaction of coke with steam and transformation of gases into water-gas occur simultaneously. Before the water-gas can be used for gasoline synthesis, removal of hydrogen sulphide and organic sulphur compounds is essential, to avoid poisoning of the catalyst subsequently used. The former is usually effectively removed by iron oxide, whilst iron oxide plus alkali carbonate and this mixture in combination with cobalt sulphide are used for the removal of sulphur compounds.

The formation of gasoline from water-gas is attributed to a first reaction into $\rightleftharpoons CH_2$ molecules which are then subject to polymerization, isomerization, and alkylation

reactions. The hydrocarbons produced consist largely of straight-chain paraffins, but changes of the operating conditions have a considerable effect on the product. Conditions under which paraffin wax is produced from water-gas are described. R. J. E.

145. Patents on Synthetic Products. N.V. De Bataafsche Petroleum Maatschippij. E.P. 527,954, 18.10.40. Appl. 24.4.39. Preparation of saturated hydrocarbons with branched or more highly branched chains from hydrocarbons boiling below about 160° C. and having five or more carbon atoms in the molecule.

M. W. Kellogg Co. E.P. 527,975, 21.10.40. Appl. 23.4.38. Method of increasing the aromatic content of a mixture of hydrocarbons containing *cyclo*-olefins, naphthenes, and aromatic hydrocarbons. The mixture is subjected to dehydrogenation in order to convert the *cyclo*-olefins into aromatic hydrocarbons and afterwards to mild conditions of hydrogenation to convert any residual olefins.

A. V. Grosse and W. J. Mattox. U.S.P. 2,217,010, 8.10.40. Appl. 31.5.38. Production of aromatic hydrocarbons from acetylene hydrocarbons by dehydrogenating and cyclicizing the acetylene hydrocarbon by subjection to a temperature between 450° and 700° C. for 0·1 to 30 sec. in the presence of a compound selected from the class consisting of vanadium, columbium, and tantalum.

O. W. Cass. U.S.P. 2,218,018, 15.10.40. Appl. 2.5.38. Manufacture of 1 : 4-dihalogen butane by reacting tetramethylene oxide with a hydrohalogen acid in the presence of a dehydrating acid.

W. Friedrichsen and W. Fitzky. U.S.P. 2,218,640, 22.10.40. Appl. 18.11.39. Production of aliphatic hydrocarbons containing conjugated double linkages by contacting a 1 : 3-dioxane with a solid dehydration catalyst. H. B. M.

Refining and Refinery Plant.

146. Improvement in Octane Number and Lead Susceptibility. D. L. Yabroff and A. C. Nixon. *Oil Gas J.*, 22.2.40, **38** (41), 74.—The effect of sweetening with "Solutizer" solution (potassium hydroxide and potassium *iso*butyrate) on octane number and lead susceptibility is described. In contrast to the conventional sweetening processes which convert mercaptans into disulphides, the "Solutizer" process extracts the mercaptans from sour gasoline. Data obtained on a large number of different types of gasolines before and after sweetening with "Solutizer" show that significant improvement of both octane number and lead susceptibility is achieved by this sweetening process. It is held that as disulphides are somewhat more detrimental to lead susceptibility than mercaptans, the saving of T.E.L. when using the "Solutizer" process as compared with that when using the conventional sweetening processes is more striking than the data provided indicate. R. J. E.

147.* Cold Acid Treatment of Cracked Distillate. Anon. *World Petrol.*, October 1939, **10** (11), 76.—A detailed description of a Stratcold plant for the cold acid treatment of heavy cracked distillate to remove sulphur compounds is given. The process consists essentially of contacting the raw distillate with 98% sulphuric acid under precisely controlled temperature conditions in a three-stage, counter-current treating system. The treated distillate is passed through a clarifier, a two-stage water-wash system, and finally contacted with caustic soda for neutralization. The distillate is treated with 9 lb. sulphuric acid per barrel, and the treating temperatures at the three stages are maintained at 30° F., 30° F., and 20° F. respectively. The equipment and method of control are described in detail. R. J. E.

148.* World's Refining Facilities. Anon. *World Petrol.*, October 1939, **10** (11), 86.—Details are given of world refining facilities (excluding U.S.A.). Plants are classified by continents and by countries, and their locations and capacities given. The position of belligerent countries in relation to their requirements of petroleum products is discussed. The development and installation of plants operating recently

developed processes—*e.g.* catalytic cracking, polymerization and alkylation, are reviewed. R. J. E.

149.* Alkylation's Place in Refining Industry. Anon. *World Petrol.*, October 1939, **10** (11), 104.—Growing demand for high-octane aviation fuel has directed particular attention to alkylation as a simpler method for the production of *iso*-octanes. Alkylation consists of reacting *iso*butane with butylenes in the presence of 98% sulphuric acid at 45–60° F. The reactants are mixed in the ratio of 1·2 parts *iso*butane with 1 part butylene. The raw alkylate is separated from the acid by gravity and fractionated to yield 92% of *iso*-octanes with an endpoint of 310° F., 2–4% of a heavier fraction with an endpoint of 400° F., which is suitable for motor-fuel blending, and a residue having an endpoint of 600° F., which can be used for power kerosine or diesel oil.

Alkylation has a distinct advantage over polymerization for the production of *iso*-octanes, in that *iso*butane is used, and so the yield is roughly twice that obtained when using refinery gases. Moreover, the hydrogenation step is eliminated in alkylation. However, whilst *iso*butane is plentiful in natural gasoline, it cannot always be delivered cheaply at the refineries. R. J. E.

150.* Catalysis in Petroleum Refining. Anon. *World Petrol.*, October 1939, **10** (11), 62.—The rôle of catalysts in petroleum refining is reviewed. The catalytic processes used in the industry fall into three groups:

(1) Break up of high molecular weight hydrocarbons (catalytic cracking).
(2) Change of product to a more desirable form (catalytic reforming).
(3) Combination of hydrocarbons to form a synthetic product of greater value (catalytic alkylation, polymerization, and hydrogenation).

Catalytic cracking represents an improvement on thermal cracking in that superior products are produced at lower temperatures and pressures. The better-quality gasoline yielded in catalytic cracking is attributed to the formation of cyclic and branch-chain hydrocarbons superior in quality to the straight-chain hydrocarbons which preponderate in thermally cracked gasoline.

In catalytic reforming the products of thermal or catalytic cracking can be improved by passage over a catalyst, and results show that this has a distinct advantage in quantity and quality over thermal reforming. The development of catalytic reforming from clay-treating processes is reviewed and present-day catalytic reforming processes are outlined.

In catalytic polymerization the C_3 and C_4 hydrocarbons form the main raw material. Various processes for the catalytic polymerization of these lower hydrocarbons to high-quality gasoline are described. Details are also given of the processes for the polymerization-cum-hydrogenation of butylenes to *iso*-octane, the combination of butylenes with *iso*butane to give alkylate octanes, and of ethylene with *iso*butane to give neohexane. R. J. E.

151.* Equipment Inspection for Greater Refinery Safety. P. N. Gammelgard. *Refiner*, January 1940, **19** (1), 8–15.—Causes contributing to failure of cracking units are classed under two types. The first is the human element, and is briefly discussed. The effect of temperature in reducing the strength of metals is not generally well understood, and many who would refuse to increase the operating pressure on a tower by 50 lb./sq. in. would not hesitate to increase the temperature 50° or 100° F., although the latter procedure might, in certain cases, be hazardous.

The fact that many parts of a cracking unit operate at temperatures above the boiling point of water points out the potential danger of introducing water in any appreciable amount into the system. The tremendous increase in volume which takes place when water flashes into steam may quickly build up pressures which relief valves will be unable to accommodate.

Modern cracking and combination units cannot be made foolproof. Regardless of the thoroughness of inspection, cracking units must be operated by careful, well-trained, and "safety-conscious" personnel.

The second class of causes contributing to equipment failure is composed of factors which to a large degree are beyond the immediate control of the operating personnel.

The adverse influence of these factors on the safety of equipment makes inspection a necessity.

Listed, without attempting to place them in the order of relative importance, they are: (1) corrosion, (2) erosion, (3) oxidation, (4) creep, (5) fatigue failure.

Refineries are fertile fields for corrosion in all its varieties. Examples of direct chemical action, pitting, dezincification, galvanic action, concentration-cell corrosion, corrosion cracking, and corrosion fatigue are common. Illustrations are described in detail to explain various methods and aspects of corrosion.

Erosion in refinery operations may be caused by any one of several factors or by a combination of them. Erosion may result from (1) high vapour or liquid velocities; (2) abrasive or gritty matter carried in the oil or vapour stream; (3) the junction of two streams; (4) coke-cleaning equipment; (5) friction between two objects. These items are briefly explained.

Flame impingement is a well-known cause of oxidation, although it is by no means a requisite for oxidation. Local overheating as a result of coke conditions or faulty firing may result in a badly oxidized tube within a short period. Under moderate oxidizing conditions, scale will form on the surface of the tubes. The insulating effect of the scale will in turn necessitate higher muffle temperatures in order to maintain the oil line, and if the situation is permitted to become progressively worse, a bulged tube will result, and ultimately a rupture.

Creep and fatigue are problems to be solved by the designers, although the operator has to understand their implications.

The determination of the inspection and testing periods should be the responsibility of the inspector in charge. The periods so determined will be the result of past findings, severity of operating conditions, and potential danger in the event of failure. Until an experience record has been built up, it is certainly better practice to "over-inspect" than "under-inspect."

A typical inspection procedure covers the following points: (1) visual examination; (2) drilling and calipering; (3) hammer testing; (4) pressure tests; (5) records and reports. These steps are detailed. A. H. N.

152.* Application of *X*-Ray Inspection to Oil Refining Equipment. H. R. Isenburger. *Refiner*, January 1940, **19** (1), 22–29.—By far the majority of large objects radiographed up to the present have been castings. Whether justified or not, there is a tendency on the part of designing and operating engineers to place confidence in forgings without subjecting them to *X*-ray inspection. On the other hand, they prefer castings for many services in oil-refinery installations, because castings may be cheaper even when they are *X*-rayed and the additional cost of the radiographic inspection is taken into account. Inspectors are strengthened in this tendency when assured of the quality of the castings. The degree of this assurance depends on their faith in the manufacturer and his workmen, and on tests applied to castings. The usual physical test consists of applying hydrostatic pressure to a value well in excess of the maximum intended working pressure. If the casting does not fail at this time, and if there is no visible evidence of damage as a result of the test, the casting will be accepted with the assumption that it has no serious defects and that it will stand the working pressure during a reasonable operating life.

This is shown not to be always a safe conclusion. An ell fitting was subjected to a hydrostatic test and apparently withstood it successfully. However, subsequent *X*-ray examination disclosed that the test had produced or extended a crack which had started from a small gas-hole or an inclusion of a foreign substance, and which had progressed about two-thirds of the way through the outer portion of the wall of the fitting. It is possible that because of this defect the ell would have failed while in service, and serious damage and injury to personnel and equipment would have resulted.

Various examples of inspecting welds and castings are studied and test technique is outlined. A warning is given against inexpert advice and interpretation of test results. A. H. N.

153.* Field Lining of Refinery Vessels with Stainless Steel Sheets or Strips. K. E. Luger. *Refiner*, February 1940, **19** (2), 41–46.—Field lining of existing vessels with stainless steel is now being done on a broad scale. Towers lined in the field nine or

more years ago are still giving entirely satisfactory service, and indicate that there is no appreciable amount of corrosion even when handling sour crudes. While it is not claimed that a lining job can be done in the field as cheaply or as perfectly as in a fabricating shop while the vessel is being constructed, it nevertheless appears to be well established that field lining can be done both satisfactorily and economically. It is estimated that in the last 2½ years alone well over 150 vessels have been field lined with thin stainless steel. They range from small heat-exchanger shells to large vacuum towers, and include a goodly number of riveted towers.

These field liners of stainless steel have been applied in various ways; in fact, it is likely that no two refineries do the job in exactly the same way. The important considerations are the fastening of the liner to the steel securely at frequent intervals and sealing it so as to prevent entry of oil or vapour between the shell and the vessel. All successful jobs embody these two features and differ only in details. These details are given with illustrations and warnings against common faults.

A. H. N.

154.* Continuous Coal Distillation Similar to Petroleum Refining Technique. B. O. Lisle. *Refiner*, March 1940, **19** (3), 63–67.—Britain's leading manufacturer of synthetic-oil products from coal recently completed a new continuous-distillation plant which is the first of its kind to be based on the technique used in refining crude petroleum, as well as embodying the latest practice in coal-tar treatment. Better fractionation and more efficient washing have improved the quality of the products. The distillation unit is of flexible design and operation, enabling it to meet varying demands, but the usual yield is about 10% motor fuel, 15% diesel oil, 16–18% cresol, 59–61% creosote and fuel oil, and the remaining 20% pitch.

Great Britain ranks third in the world consumption of petroleum, requiring approximately 11,430,000 brl. of gasoline, 1,280,000 brl. of diesel oil, and 14,280,000 brl. of lubricating oil. Of this, however, only about 8% of total requirements are produced from indigenous sources; some from distillation of the hydrocarbon content of the Scottish shales, but most is from heat treatment of coal. Petroleum production is negligible, despite the several million dollars spent during the past five or six years in drilling operations all over the United Kingdom.

The plant is briefly described, with a tribute to Colonel Bristow's enterprising work.

A. H. N.

155.* Treatment of High-Sulphur Cracked Distillate with Stratcold Process. F. A. Apgar and C. A. Day, Jr. *Refiner*, April 1940, **19** (4), 97–101.—In the refining procedure, cracked distillate is split into a heavy and light fraction by the usual debutanizing and stabilizing operations. The heavy fraction, having a boiling range of 220–410° F., contains the refractory sulphur compounds and is subjected to the Stratcold treatment; the light fraction contains sulphur compounds which are satisfactorily removed by caustic washing. The acid-treated distillate is re-run and the overhead blended with the caustic-washed light fraction for sweetening.

In the Stratcold treatment, cracked distillate is contacted in three stages with counter-current flow of acid. The treated distillate is then passed upward through a clarifier or rock-packed tower for further separation of acid sludge, thence water-washed, and finally neutralized with caustic soda solution.

The plant was designed to treat 11,000 brl./day of heavy cracked naphtha with 9 lb. of 98% sulphuric acid/barrel of naphtha with temperatures on the stages maintained at 30° F., 30° F., and 20° F., respectively.

The plant and various equipment and instruments are described and data are tabulated for a test run. Operations are smooth and appear to be economical.

A. H. N.

156.* Solid Copper Sweetening Process. Anon. *Refiner*, April 1940, **19** (4), 113–116.—The reagent of the solid copper sweetening process is composed of fuller's earth impregnated with an aqueous solution of cupric chloride. The function of the fuller's earth is only that of a carrier for the cupric chloride solution, and in this form has no value as a treating agent.

Two separate engineering lay-outs are followed; one when the commodity contains

both hydrogen sulphide and mercaptan sulphur, and the other when the gasoline is free of H_2S, and contains only mercaptans. To sweeten any gasoline, whether straight-run or natural, the material must be free from hydrogen sulphide before it enters the solid copper reagent treating towers. For the elimination of this sulphur compound, a series of vessels and operating equipment are included which utilize an aqueous solution of commercial caustic.

The plant's requirements and operations are detailed. Maintenance of a solid copper-sweetening plant is almost negligible, consisting almost entirely of maintaining the proper ratio of air to gasoline, and preventing the intrusion of excess suspended water or slugs of water from any source.

The total quantity of gasoline that may be sweetened with a given volume of copper chloride depends on the sourness of the gasoline, the absence of free water in the product as it enters the columns, the complete elimination of H_2S from the commodity before it enters the columns, and the common everyday attention any process should have.

A. H. N.

157.* Developments in Distillate Recovery. L. S. Reid and R. L. Huntington. *Refiner*, May 1940, **19** (5), 131–137.—The development and recovery methods in distillate fields of the Gulf Coast are described. Retrograde condensation and distillation are briefly reviewed; interest in this field of scientific research has increased since industries began using extremely high-pressure techniques.

Repressuring and pressure maintenance in general is similarly reviewed and the importance of gas conservation, maintenance of a single gaseous phase in distillate reservoirs instead of a two-component system, the reduction of gas mixing between virgin distillate fluid and repressuring gas, and prevention of a too-rapid edge-water encroachment is stressed and explained.

In determining the optimum recycling pressures for plant design, many variables are to be considered: permeability, thickness and extent of the reservoir formation, the composition of reservoir fluid, reservoir pressure, and the relative value of distillate to that of dry gas are major items. However, the problem may be simplified by assuming constancy of these factors and solving by balancing recompression cost and distillate return both as functions of the pressure of the first-stage separator.

Few phases of the industry have seen such rapid improvements as distillate-recovery plants, and it is stated that certain projects became obsolete within a year from completion. The more important processes are described and illustrated. A. H. N.

158.* Butane Chilling of Absorption Oil Increases Plant Yield. Anon. *Refiner*, May 1940, **19** (5), 144–145.—By reducing the temperature of absorption oil by 20° F. an increase of 2000 gal./day of natural gasoline was obtained—not including improved yield of butane and lighter fractions. The temperature reduction is accomplished by expanding a normal butane cut in a closed system of shell-and-tube exchanger, through which butane is continuously circulated. The unit is compact and semi-automatic. To obtain the full benefit of butane cooling, the tubes through which the oil flows are about four-fifths submerged with butane liquid, following closely the flooded refrigeration systems used in refineries when dewaxing oils.

The quantity of oil cooled is 240,000 gals./day of 37–38 A.P.I. gravity, and the quantity of butane required to cool it 20° F. is 600,000 cu. ft./day. A. H. N.

159.* Synchronized Controls Improve Boiler Operation. Anon. *Refiner*, May 1940, **19** (5), 151–152.—Synchronizing the controls in the boiler-room was accomplished through an arrangement of valves, piping, and linkage so that the draught through each boiler was automatically adjusted to the quantity of steam generated and the amount of fuel consumed. The boilers had multiple services in the refinery, furnishing steam for the gasoline plant, and power for drilling wells, for oil-treating plants and clean-out operations in the field.

Detailed description of the arrangement is presented and illustrated.

Frequent tests of stock gases were made after the controls were installed in order to adjust the travel ranges of the controls. After the tests, it was found that the operation of the assembly became fully automatic and required no further adjustments, except where excessive wear of pins necessitated them. A. H. N.

160.* Caustic Embrittlement of Steam Boilers. W. S. Cazort. *Refiner*, May 1940, **19** (5), 156–158.—Caustic embrittlement is a series of intercrystalline breaks in seams and joints of boiler-plates, and particularly between rivet holes. This condition results from the conversion of sodium bicarbonate into sodium hydroxide, through the formation of the intermediary sodium carbonate, by the action of the heat supplied by the boiler. The caustic soda increases in concentration, and when it is in excess of 2 gm./litre under pressure and high-temperatures it causes this cracking between rivets and seams, with disastrous consequences.

Two agencies for the prevention of caustic embrittlement are soluble sulphate and phosphate salts. For every boiler pressure there is an optimum sulphate to carbonate ratio, ranging from 1 : 1 to 3 : 1 as pressure rises from 5 to 250 lb./sq. in., which will completely eliminate embrittlement by caustic soda. Most alkaline waters contain a certain amount of sulphates, thus only complementary quantities are required to raise the sulphate content to the required ratio.

The determination of alkalinity and the calculations involved in checking alkaline embrittlement are detailed and illustrated by an example which is worked out numerically. A. H. N.

161.* Gas Lift Combined with Gasoline Manufacture. Anon. *Refiner*, May 1940, **19** (5), 159–162.—A plant which was designed with a view to gas lift as well as gasoline manufacture also deals with a varying load of gas the peak load of which is 12,000,000 cu. ft./day. The quality of this gas, in so far as gasoline content is concerned, varies by the method of producing the oil. Field tests indicate that the content ranges from 1 to 4 gal./1,000,000 cu. ft., but the average is around 1·20 gal. Content of the gas may range from 1 gal. up to 4 gal., depending on the class of wells from which the gas is being taken, and also on the manner in which the wells are produced, whether they are opened wide for the daily allowable, or produced in a more orderly manner. On an average, the plant produces around 1·10 gal./1,000,000 cu. ft. of 18 lb. gasoline, and about 1·00 gal./1,000,000 cu. ft. of butane, the two varying according to whether the main product of gasoline requires a larger or smaller quantity of butanes for vapour-pressure control.

The gas is received through three trunk vacuum lines. The vacuum is held down as low as possible to bring in the gas without excessive back pressure on the field equipment, and so that a minimum amount of air will be drawn into the gathering system. A high vacuum is most detrimental in a field of this nature where quantities of H_2S are contained in the gas, due to the higher rates of corrosion of equipment when this sulphur compound is acted upon by oxygen and passed through iron or steel pipes and vessels. A. H. N.

162.* Selection of the Most Economical Pipe and Valve Size and Rate of Flow in Piping Systems. S. P. Johnson and F. L. Maker. *Refiner*, June 1940, **19** (6), 169–180. *Paper Presented before American Petroleum Institute.*—The phase of the subject covered by this paper is limited to the proper choice of pipe size to give a balanced and economic cost value. The size of long pipe-lines is usually determined by balancing pipe cost against pumping cost. As a formal economic study for each element of a plant piping system would be out of the question, various shortcut methods are commonly employed, the most usual being to assume a reasonable velocity or a reasonable pressure drop on the basis of experience or common sense. This paper examines these methods and shows that they are apt to err when the density or viscosity of the fluid is unusual or when special materials are required. A rational method of selecting pipe size for any fluid is worked out, and charts are included which permit the economic selection of size to be made with a minimum of calculation.

It is shown that valves, and sometimes other appurtenances, are not necessarily best made the same size as the line. The economy of small-size valves has been worked out, and suggestions are made for installation.

The flow rate in a piping system is usually dictated by process requirements or basis assumptions. There are, however, interesting exceptions when the designer of the piping must chose the flow rate as well as the pipe size to secure the lowest overall cost. One of the most important problems of this class arises in designing a loading system for tank-ships, tank-cars, or trucks when a three-way balance should be struck

between pipe cost, pumping cost, and cost of delay. This problem is simplified by the development of a chart showing the most economical flow rate for any given or assumed loading system. A. H. N.

163.* Application of Superheated Steam to Combination-Unit Prime Movers. A. E. Harnsberger. *Refiner*, June 1940, **19** (6), 181–184. *Paper Presented before American Petroleum Institute.*—Combination cracking units of large capacity, involving as they do heavy pumping loads, present a power problem to the refiner. This paper summarizes an investigation made by a refiner on the best method to meet the power requirements of a 25,000-brl. crude-charging-capacity combination unit. It was necessary to adapt the installation to meet the limited steam-production facilities in an existing plant.

The investigation revealed the practicability of generating steam from waste heat. By superheating the steam to the largest power-consuming units, and by condensing the steam from these units under vacuum, it was possible to reduce the steam requirements and make a boiler-house extension unnecessary. Operating data are given showing that original design expectations are being achieved. A. H. N.

164.* Removal of Sulphuric-Acid Fog by Bubble-Phase Absorption. D. W. Bransky and F. F. Diwoky. *Refiner*, June 1940, **19** (6), 191–195. *Paper Presented before American Petroleum Institute.*—Various methods of the removal of H_2SO_4 droplets from the stack gases of sulphuric-acid manufacturing and concentrating plants have been evaluated. The various known methods have been divided into two categories, viz., effective and ineffective, according to the practicability of the method from both the viewpoint of sulphuric-acid removal and the economic picture. Effective methods such as (1) the filtration of the stack gases through various wetted media; (2) the decomposition of acid mist by heating to 1000° F. or above under controlled conditions of combustion; (3) the use of Cottrell precipitators; (4) the use of steam ejectors with subsequent condensation of the steam; and (5) the use of turbo-mixers were discarded because of high investment or high operating costs. A new method, in which the gas is bubbled through an aqueous solution of a foam-producing substance, has been found to be extremely effective in removing H_2SO_4 droplets, and has a very low investment cost.

The most effective foam-forming agent found consists of the sulphonic acids obtained from the hydrolysis product of the acid sludge derived from the treatment of petroleum. These acids are readily soluble in water, form a relatively stable bubble phase in a dilute aqueous or sulphuric-acid solution, and are soluble in aqueous solutions of H_2SO_4 containing up to 10% acidity. A laboratory investigation subsequently followed by a pilot-plant investigation indicated that the method was effective in removing approximately 90–98% of the H_2SO_4 in the incoming gas, and that the efficiency of the H_2SO_4 removal was practically independent of the concentration of the H_2SO_4 in the gas and the temperature of the solution over ranges of 80–186° F. It was found also that the efficiency of removal was affected greatly by contact time. The pilot-plant experiments demonstrated that, with a contact time of 10 sec. to 11 sec., approximately 93–95% of the total H_2SO_4 may be removed in continuous equipment having a pressure drop of approximately 2 in. of water. Economic calculations have indicated installations, operating, and repair cost to be approximately 50% that of equivalent electrical precipitation equipment. A. H. N.

165.* Chemical Removal of Scale From Refinery Equipment. L. W. Lee. *Refiner*, June 1940, **19** (6), 222–224.—To be assured of successful results by chemical removal of industrial scale deposits from heat exchangers, cooling coils, condensers, I.C.E. cooling jackets, and other types of equipments, it is necessary to know the exact composition of the scale. The usual tests are carried out with portable solubility test apparatus; in more difficult cases *X*-ray powder diffraction patterns are obtained for the determination of chemical composition of the crystalline material. The same crystalline material gives the same pattern, which is unique to the crystal. From these tests the solvent to be used is determined.

The manner of introduction of the solvent is very important; best results have been obtained by introducing fresh solvent into the vessel to be serviced by as many

avenues as possible. The solvent is circulated back to the tank and again into the equipment.

A recent type of heat-exchanger departs from the conventional type by having spines extending from the pipe in great numbers, so as to increase the heat-exchanging area by as much as 20 times the normal. The removal of scale and sludge from such an irregular and spiky surface is particularly adaptable to chemical treatment in preference to mechanical.

Tower trays and other similar equipment can be descaled in some 36 hr.—a much shorter time than would be possible if the equipment were dismantled and cleaned mechanically. A. H. N.

166.* Rolling-in of Upset and Close Tolerance Machined Tools for Cracking Furnace Installations. F. C. Braun and M. Fleischmann. *Refiner*, July 1940, **19** (7), 225–231.—In order to gain information in regard to certain variables in the rolling-in technique which may affect tightness and safety of rolled joints, three big companies conducted an investigation, the conclusions of which were :—

The header material should be considerably harder than the tubing, to assure well-developed shear points. It is suggested that headers for the installation of alloy tubes with a maximum hardness of 163 Brinell should be heat-treated to a hardness of 220 Brinell minimum. In general, it is recommended that the hardness of the header should exceed the hardness of the tubes by a minimum of 60 Brinell numbers.

There is an optimum amount of expansion for each tube size which will produce best shear points and tightest fit. Not only insufficient rolling, but also too much rolling will cause joints of doubtful quality. Too much expansion of the tube into the tube hole will result in an excessive flow of the tube material out of the header, with the danger of shearing off proper shear points which already have been formed.

The use of wide-angle flaring rolls on the expander tool should be discouraged, as the flaring of the tube ends will cause a longitudinal flow of the tube material, injuring satisfactory shear points formed by the expander rolls.

The procedure and test results of the investigations are reported, and a chart indicates recommended expansion for a given size tube end, upset and machined to close tolerance. A new rolling-in tool is described and illustrated. A. H. N.

167.* Refrigeration and Dehydration Fit Plant into Repressuring System. Anon. *Refiner*, July 1940, **19** (7), 235–239.—In order to fit a natural gasoline-manufacturing plant into the repressuring programme of a field, compression, refrigeration, and dehydration have been incorporated in the plant.

Three stages of compression are used. In the first, gas is drawn from the field and boosted to around 40 lb./sq. in. gauge. In the next it is increased to 300 lb., while the third is to 1800 lb. for formation repressuring.

The first stage is typical gasoline-plant practice, drawing the gas through the gathering system at the field pressure, and boosting it to 40 lb. gauge. The gas is cooled in atmospheric sections set in a water-cooling tower and scrubbed to remove liquids produced. The condensate accumulated in this stage consists of high-boiling fractions which are combined with final production for further processing. No attempt is made to reduce the temperature of the gas at this low pressure below that obtained in conventional atmospheric-section cooling, and the gas is then picked up by the intermediate cylinders, which raise the pressure to 300 lb. gauge. The intermediate cooling is accomplished in atmospheric cooling sections, and the gas and condensate then enter the refrigeration and glycol dehydration units without separation.

The refrigeration side of this plant is handled by expanded propane contained in a closed system and recycled, much the same as other plants use *iso*butane or a rough cut of propane-butane from the stabilizer reflux when cooling absorption oil and commodities when atmospheric conditions are unfavourable for low temperatures by ordinary water cooling. Two horizontal gas engines compress the gas and deliver it to atmospheric condensers with the liquid product passing to a surge-tank. From this tank the liquid passes to the propane flash-tank, and from there to the propane chiller, counter-current to the stream of gas, gasoline, and glycol, and thus, when returned to the engines, completes the cycle. A. H. N.

168.* Aviation Gasoline Plant Near the Arctic Circle. R. E. Parkhurst. *Refiner*, July 1940, **19** (7), 240–245.—The most northerly refinery in the world has recently been completed within 100 miles of the Arctic Circle. Many difficulties were encountered and some of these are recounted.

The means of transportation imposed certain physical restrictions due to the size of the barges and type of trucks operating on the Fort Fitzgerald–Fort Smith portage road—no single piece could be over 10 tons in weight or occupy more space than 10 × 10 × 35 ft. long. Some welding was done on pipe supports, but generally all equipment had to be bolted, contrary to general practice. Maximum permissible pipe diameter was 4 in., on account of absence of facilities at the site for handling larger sizes. Some local lumber was available, but the general use of wood was ruled out. Even gin-poles for erection were shipped in. Because of scarcity of local skilled labour and a round trip transportation cost of $420 per man, and in order to reduce erection time to the minimum, it was necessary to assemble all equipment in the shop, so far as possible. Since Arctic weather conditions and open water would permit operation of the refinery only 90 days a year, the refiner desired as low an initial cost as possible for the installation, combined with low maintenance costs. Many other difficulties were due to the fact that the frost-line is some 50 ft. below ground and the ground never thaws out.

The plant was designed for three alternate operations, producing a stabilized gasoline of 270° F. Engler F.B.P., sidecut of light diesel fuel oil, and heavy fuel-oil bottoms for stationary diesels with approximate yields, respectively, of 19%, 41%, and 29%. The sidecut can be eliminated, running all the fuel oil as bottoms. It is also possible to run a 400° F. end-point motor gasoline overhead and take diesel fuel oil as bottoms.

A. H. N.

169.* New Principle in Boiler Feed-Water Level Control. J. A. Campbell. *Refiner*, July 1940, **19** (7), 246–249.—It was reported in a previous paper (*Refiner*, February 1937, p. 60) that good results were obtained from a thermostatic-tube type of boiler-feed regulator. In the previous report an inclined brass tube was set up, 48 in. long and ¾ in. in diameter, and alongside of it a gauge glass with thermometer well at each end. The upper end of the tube was connected into the steam space at the top of the water column, and the lower end to the water column near the bottom, well below the water level. These connections permitted the water to seek its own level in the tube. This level checked lower than the level in the glass column, which is always lower than the actual level in the boiler. Two reasons are given for this: (1) frothing of water in the boiler by the steam bubble reduces the density of the water there by some 15%; (2) the temperature effect.

In this paper a development of a still better and very sensitive regulator is given. An interesting part is where the expansion is multiplied by using a geometrical truth. A tube which gets hot and cold, and thus regulates a valve travel, is incorporated in a triangular set of bars. It is a principle in geometry that a triangle, so long as its legs remain straight, cannot be changed in shape without changing the length of one of the legs. When the tube gets hotter, due to falling water level, it lengthens. It cannot lengthen along its own axis because of the restraining bar, which remains of fixed length, so the outer end of the tube must swing upward on the arc. This upward movement, due to the ratio of tube length to the spread between the two anchored ends, is six times as great as the actual increase in tube length due to expansion. The arc having a radius of 42 in. and the movement of the outer end casing along the arc being relatively small, for all practical purposes, must be regarded as a vertical movement. From cold tube to steam-filled tube at 150 lb. pressure this vertical movement is 1 in.

A. H. N.

170.* Graphical Methods Applicable to Refinery Problems. J. W. Greene. *Refiner*, August 1940, **19** (8), 268–274.—The paper is an adaptation of simple graphical interpretation of elementary differential and integral calculus to problems met in the refinery, and is based on the fundamental concepts that the slope of a curve is its differential coefficient and the area bounded by a curve and two ordinates at two abscissa values and the x-axis is its integral between the limits of the abscissa. An example on enthalpy and heat capacity illustrates the use of graphical differentiation and integration.

Three methods are used to illustrate an integration example in the design of an absorption tower where the volume of the tower is required.

Solution of quadratic and cubic equations graphically by reducing the problem to two functions which, when plotted, yield a curve and a straight line intersecting at the roots of the equation in the usual manner forms part of the paper.

It is noted that if average conditions are used, instead of point conditions accurately determined, errors will be introduced into the calculations.

The paper is clearly written and well illustrated. A. H. N.

171.* **Annealing Furnace Permits Re-Use of Still Tubes.** Anon. *Refiner*, August 1940, **19** (8), 280–281.—An annealing furnace is described which was designed for reconditioning equipment in a refinery, after welding ends on to tubes to replace parts damaged by corrosion and erosion. After welding, the tubes are swung by cranes on to an oven, which is controlled by three thermocouples suitably placed, and all openings in the super-structure are closed by plastic insulation similar to that applied to a boiler by mixing with water and trowelling on. The temperature is gradually raised throughout the oven, and at least two-thirds of the lengths of the tubes are at a uniform temperature.

Photographs illustrate various aspects of the process and the furnace. A. H. N.

172.* **Fractionation Concentrated at One Plant.** Anon. *Refiner*, August 1940, **19** (8), 297–298.—A plant is described where all fractionating equipment are grouped at one point, the gasolines manufactured in various plants being pumped to this centralized fractionation unit. Feed control and arrangement as well as reconditioning systems and blending operations are described. A. H. N.

173.* **Suspended Walls.** H. O. Johanson. *Refiner*, August 1940, **19** (8), 299–300.—Five reasons are given for the failure of a refractory lined wall: melting, softening, spalling, fluxing, and expansion. Suspended walls greatly reduce, and in many cases entirely eliminate, the causes of these failures, and thus most refinery oil-stills and boilers are installed with suspended walls.

There are only rare cases of failure by melting, and many failures which appear to be due to melting are in reality due to fluxing.

Softening is, on the other hand, a major cause of trouble. The bricks near the bottom of the furnace wall soften, and the result may be the collapse of the inner surface of the furnace. Air-cooled suspended walls improve this condition, as the lower bricks are not raised to the softening temperature and do not carry heavy weights. The walls should be thin, and for air-cooling should not exceed 10 in.

Spalling is the effect produced by alternately heating and cooling the fire-bricks. Suspended walls do not suffer badly, as the bricks are not constrained.

Fluxing results from the interaction of the ash with the firebrick, with the result of forming a fluid, at the high temperatures operating, and washing away the bricks. This appears as if failure were by melting. Air-cooled suspended walls again remove this trouble, as solid ash cannot react with the bricks. Excess air in the fuel is another remedy, but the stack losses are then high.

Expansion troubles in ordinary walls are due to the fact that the wall behaves monolithically. In suspended walls each section of the wall is independent of all other sections, and is therefore free to expand.

Sectional supported walls are briefly discussed, and usages in designs for boiler work and oil stills are outlined. Experimentation is still being carried out on various designs. A. H. N.

174.* **Processes in Refining Petroleum.** Anon. *Refiner*, September 1940, **19** (9), 313–353.—A section on process development is presented in which a flowsheet and a page of description are given for each process which is either newly developed in 1940, or which has shown material changes either in flow diagram or description during the same period. The information is compiled either from the holder of the patent or from the concern privileged to license the process.

The following processes are described and illustrated: Badger Distillation Processes;

Bari-Sol Process (centrifugal dewaxing); Duo-Sol Solvent Extraction Process; Filtrol Fractionation Process (highly activated bleaching clay used); Speciality Absorption Process (for propane); Furfural Refining Process (solvent refining of lubricating oils); High-Pressure Gas Recycling Process (for pressure-maintenance in distillate fields); Houdry Catalytic Cracking Process (high octane gasoline and aviation fuel); Houdry Catalytic Treating Process (vapour phase); Polyform or Gas Reversion (see Abstract No. 140); Perco Catalytic Desulphurization; Perco Copper Sweetening Processes; Pure Oil Thermal Polymerization (high-octane blending stock from gases); Sharples Dewaxing Process (centrifugal dewaxing); Shell Phosphate Process (removal and recovery of H_2S); Regenerative Mercaptan Removal; Shell Solutizer Process (sweetening gasoline); Sulphuric Acid Alkylation Process; Catalytic Polymerization Process (U.O.P. Midget and large scale plants are described); and X-YTE Percolation Filtration Process. A. H. N.

175.* Depropanization of Butane. L. J. Coulthurst. *Oil Gas J.*, 11.7.40, **39** (9), 50; *Nat. Pet. News*, 10.7.40, **32** (28), 50.—Propane is frequently present in gasoline in insufficient quantities to justify the installation of a depropanizer, and is lost during handling and storage, taking with it some of the more valuable hydrocarbons. The extent to which large percentages of butane can substitute small percentages of propane to give gasolines of required vapour pressure is discussed. For final vapour pressures of 8, 10, 12, and 14 lb. respectively, 1 brl. of propane may be substituted by 4·7, 4·9, 5·1, and 5·3 brl., respectively, of butane. In such cases the butane possesses gasoline value. In one case the installation of a catalytic polymerization unit, removing the propylene and butylenes, gave a sufficiently high propane concentration in the residual butane to warrant the installation of a butane depropanizer. The substitution of propane by this propane-free butane increased the gasoline production sufficiently to make the installation an economic success. C. L. G.

176.* Doctor Test has Indirect Value. W. A. Schulze. *Nat. Petrol. News*, 7.8.40, **32** (32), R. 290.—The article suggests that although the consumer is less conscious of odour as a significant property of gasoline, sweetening processes are still worth while. Data are presented to show that the gum stability of a sweetened spirit is greater than that of a sour gasoline, provided that the sweetening process does not remove natural inhibitors. Sour gasolines are shown to suffer a loss in octane number when exposed to sunlight, a factor stated to be of significance when the gasoline is dispensed from "visible bowl" pumps. The "Doctor Test" is defended as safety device for the refiner. H. G.

177.* New Dehydration-Refrigeration Plants Involve Use of Diethylene Glycol. H. L. Flood. *Petrol. Engr*, May 1940, **11** (8), 113.—The use of diethylene glycol as a dehydrating agent in gasoline plants operated in connection with repressuring operation so that the efficiency of the glycol is increased by operating at a lower temperature whilst the gasoline yield is also increased.

The gas is first scrubbed and compressed in two stages to 300 lb., separated water and condensed gasoline being drawn off. Diethylene glycol is then injected into the gas stream, which is subjected to initial chilling in a series of heat exchangers and then passed into a propane chiller. The gas is then passed to a main gasoline separator at 300 lb. and then through three further separators at 135 lb., 70 lb., and 50 lb., respectively. Absorption of water by the diethylene glycol occurs continuously during the chilling and separation processes. The dilute glycol–gasoline mixture is settled in the last separator, the former being pumped into raw gasoline storage and subsequently stabilized, and the latter drawn off into a glycol still, where it is reconcentrated. The gas is compressed to 1800 lb. and returned to the field. It has a dew-point of 40° F., and this is considered to be satisfactory for hydrate-free operation during the greater part of the year. R. J. E.

178.* Developments in the removal of H_2S From Natural and Refinery Gases. W. A. Leech. *Petrol. Engr*, Mid-Year 1940, **11** (10), 97.—A wide variety of processes for the removal of H_2S from gas is now available, some providing by-products of sufficient value to pay for the cost of purification. Recently installed plants utilize the following

processes: (1) absorption in amines, in one case incorporating diethylene glycol dehydration; (2) absorption in potassium phosphate, removing 95% of the H_2S from a sour gas; and (3) treatment with iron oxide (this being considered the simplest and cheapest means of purifying small quantities of low H_2S content gas in isolated locations). Several refineries have installed processes for the recovery of H_2S as sulphur or sulphuric acid (for use in alkylation processes, etc.). C. L. G.

179.* Effect of Atmospheric Conditions on Diesel Engine Performance. J. S. Doolittle. *Oil Gas J.*, 1.8.40, **39** (12), 42.—A study has been made of the effect of variations in pressure, temperature, and humidity of the air on the performance of a two-cycle diesel engine, running under at least 10 different loads varying from 30% rating to the maximum possible with steady operation. Humidity effects were examined with intake air at 80° F. and at 48% and 90% humidity, and at 120° F. with 27% and 90% humidity, and temperature effects with air at 45° F., 80° F., and 120° F. Intake pressures were varied from 22·5 to 33·5 in. Hg at constant exhaust pressure, and exhaust pressures from 29 to 31 in. Hg at constant intake pressures. In other tests equal intake and exhaust pressures from 29·4 to 31 in. Hg were used. The tests indicated that at loads lower than the load of minimum fuel rate, changes in air density as high as 15%, resulting from variations in any or all of the factors examined, have little effect on the fuel rate. With loads in excess of this, changes in intake air pressure, temperature, humidty, or exhaust pressure affect the amount of air taken into the cylinder, and hence influence both the fuel rate and the maximum power output. Further, if the pressure differential between the scavenging air and main cylinder pressure is abnormally small, changes in either the exhaust or intake pressures will affect the air supply to the engine, and hence fuel rate and maximum power output. C. L. G.

180.* Conserving Lubricating Oil. C. I. Kelly. *Petroleum*, August 1940, **2** (4), 111–122.—This is a plea for the recovery of used lubricating oils on a national basis.

The author is of the opinion that while the nation is fully conscious of the part played by liquid fuels in the national life, and of the necessity of conserving supplies, it does not realize the important part played by lubricating oil. This may in part lie due to the fact that whilst liquid fuels amount to 80% or more of the total petroleum imports, lubricating oil represents only 3·5% of these imports.

Used oils can be reclaimed and refined into oils indistinguishable from new straight mineral oils at a cost lower than the new oil in war-time. Two processes are discussed: (1) that using activated earth followed by filtration and sometimes by removal of diluent; (2) a chemical treatment with H_2SO_4 followed by neutralization and earth treatment.

Two types of small recovery plant are described, both using the activated-earth treatment, and analyses of aero oils recovered by these methods are compared with the requirements of the DTD. 109 specification.

The question of the collection of crankcase drainings for recovery treatment is discussed. D. L. S.

181.* Recovery Progress. A. T. Wilford. *Petroleum*, August 1940, **2** (4), 123.—The heavier types of lubricating oils, particularly if badly contaminated, are not suitable for recovery. These, however, constitute only a fraction of the total volume of waste lubricants, which are mainly derived from I.C. engine crankcases and which are of medium or light viscosity.

While at first sight it might seem logical to return used oil to the refineries for treatment, the problem of the transportation of relatively small quantities of different grades would arise. There is much to be said in favour of the installation of small plants at individual garages or groups of garages.

The recovery treatment necessary depends to some extent on the condition of the oil, and thus the frequency with which the oil is changed. Simple filtration can be used quite successfully in some cases. In others, however, it is necessary to top, earth treat with or without a preliminary acid treatment, and then filter. Steps are being taken by London Transport to reclaim oil both from petrol engines and C.I. engines, and the results obtained so far are regarded as satisfactory. D. L. S.

182. Application of Welding to the Petroleum Industry. M. Couturier. *Sci. et Ind.*, 1940, 290 bis (Supplement to *Revue Mechanique*), 92–98.—Welding has found application in the construction of fractionating towers, storage tanks, liquid gas holders, pipe-lines, etc. The applications of the process to a variety of petroleum engineering problems are reviewed. T. C. G. T.

183. Struggle Against Corrosion in the Petroleum Industry. G. Daric. *Sci. et Ind.*, 1940, 290 bis (Supplement to *Revue Mechanique*), 86–91.—This paper gives an account of the various forms of corrosion—chemical, electrolytic, galvanic, etc.—and the symptoms observed from each, together with the mechanism of their action and the precautions to be taken. It also reviews corrosion occurring in underground pipe-lines, storage tanks, and corrosion in cracking tubes operating under conditions of high temperatures and pressures and, in conclusion, considers corrosion-resisting steels. R. D. S.

184.* Acid Clay and Activated Clay in Japan. Anon. *J. Soc. Chem. Ind. (Japan)*, 1940, **43** (10), 303 B.—The principal deposits of acid clay are found in the north of Japan, and are mined in the usual way—viz. the raw acid clay is dug out with pick and shovel in the open air and conveyed on trucks to a nearby factory, where it is crushed into lumps and dried by direct heat in iron pans. The geological origin of Japanese acid clay is obscure, but it is thought to be produced by the natural decomposition of a certain felspar which is contained in igneous rocks such as liparite. Owing to the absorptive and catalytic actions of the clay, it has many industrial applications, and is employed in the following processes: the recovery of natural gasoline from natural gas; decolorization of mineral and fatty oils; removal of sulphur compounds from industrial gases, mineral oils and solvents; dehydration of alcohol; preparation of cracked gasoline from heavy oils and the preparation of lubricating oils and artificial resins from cracked oils derived from mineral and fatty oils. A highly efficient activated clay has been made from the natural acid clay which is extensively used in the refining of high-grade lubricating oils. B. M. H. T.

185. Patents on Refining and Refinery Plant. N.V. De Bataafsche Petroleum Maatschippij. E.P. 528,610, 1.11.40. Appl. 18.5.38. Method of refining hydrocarbon mixtures in the vapour phase with sulphuric acid and/or water-soluble hydrogen sulphates. The hydrocarbon vapours are contacted at an elevated temperature with dilute aqueous solutions of sulphuric acid and/or hydrosulphates in quantities which are practically completely converted into sludge during the reaction.

N.V. De Bataafsche Petroleum Maatschippij. E.P. 528,611, 1.11.40. Appl. 10.5.39. Process for refining hydrocarbon mixtures in the vapour phase with organic sulphonic acid. The hydrocarbon vapours are contacted at an elevated temperature with a dilute solution of an organic sulphonic acid, if necessary together with sulphuric acid, in a chemically inert solvent which is volatile under the reaction conditions.

Standard Oil Development Corp. E.P. 528,766, 6.11.40. Appl. 5.5.39. Method of revivifying spent decolorizing adsorbent used in the decolorization of oils. The adsorbent is treated with an aqueous treating liquid, which is immiscible with the liquid adsorbed on the adsorbent, at a temperature between 300° and 710° F., and under a pressure sufficient to maintain the treating liquid in the liquid phase throughout the operation.

Standard Oil Development Corp. E.P. 528,919, 11.11.40. Appl. 8.5.39. Improvements in design of apparatus for carrying out reactions between finely divided solids and fluids. The improvements relate more particularly to apparatus for the cracking of petroleum hydrocarbons with the aid of a finely divided solid catalyst and to the subsequent regeneration of the catalyst.

N.V. De Bataafsche Petroleum Maatschippij. E.P. 529,210, 15.11.40. Appl. 24.5.39. Process for splitting up two or more chemically related organic substances into two components or groups of components by treatment with two liquids, led in counter-current, which are mutually immiscible or miscible only to a slight extent. Examples of mixtures which can be split up are mixtures of nitrogen bases which can

be separated with sulphuric acid from the acid sludge formed in the treatment of gasolines obtained by cracking special mineral oils.

Manchester Oxide Co., Ltd. E.P. 529,455, 21.11.40. Appl. 26.5.39. Process for treating spent sulphuric acid from petroleum refining by the use of a solvent consisting of or containing a substantial proportion of an aromatic hydrocarbon. The spent acid is treated simultaneously with the solvent and with water.

N.V. De Bataafsche Petroleum Maatschappij. E.P. 529,873, 29.11.40. Appl. 9.6.39. Process for refining hydrocarbons, preferably in the vapour phase, with phosphoric acid. Cracked benzene, fuel oil, and other distillates treated in accordance with the invention obtain a good colour, high oxidation stability, and show little or no tendency to gum formation.

N.V. de Bataafsche Petroleum Maatschappij. E.P. 529,997, 3.12.40. Appl. 31.5.39. Removal of mercaptans from hydrocarbon oils by treatment with an aqueous solution of caustic alkali. The invention has particular reference to the use of aqueous solutions of alkali metal hydroxides containing substantial amounts of alkali metal alkyl phenolates for carrying out the treatment.

H. G. Vesterdal. U.S.P. 2,216,968, 8.10.40. Appl. 28.5.40. Refining heavy hydrocarbon oils by treating with dilute aqueous caustic soda under sufficient pressure to maintain the oil and caustic-soda-solution liquid at the operating temperature. Thereafter the dilute caustic-soda solution is removed, together with the extracted material from the oil by decantation.

A. Shapiro. U.S.P. 2,217,387, 8.10.40. Appl. 24.7.39. During demulsification of petroleum the hydrogen-ion concentration of the water is brought within the range p_H 5·5–p_H 4·8 by adding to the emulsion a reagent capable of neutralizing excess acidity or alkalinity.

C. E. Dolbear. U.S.P. 2,221,183, 12.11.40. Appl. 24.4.36. Method of sweetening petroleum distillate by contacting with a reactive material selected from the group consisting of mercuric and cadmium oxides. A chemical conversion of "sour" mercaptan is thus caused. The distillate is then removed from contact with the reactive material and contacted with a divided solid adsorptive base-exchange zeolite to cause removal of dissolved mercaptides. Finally the distillate is separated from the zeolite and removed mercaptides.

E. Scheller. U.S.P. 2,221,559, 12.11.40. Appl. 20.10.37. Bleaching of oils, fats, and waxes by contacting in the emulsified state with an oxidizing agent in order to effect a partial bleach. Thereafter an acid is added in an amount sufficient to break the emulsion and an alkaline agent added to the product in sufficient amount to neutralize the free organic acid present. Finally the product is bleached in the liquid or molten state with hydrogen peroxide.

B. Malishev. U.S.P. 2,223,524, 3.12.40. Appl. 12.8.39. Refining cracked gasoline by treating with a catalyst consisting of a solid calcined product of a mixture of a substance taken from the group consisting of a mineral phosphate, superphosphate, and Thomas slag, with sulphuric acid. The treatment is conducted at a temperature between 150° and 300° C. and at a pressure sufficient to maintain the liquid state.

H. B. M.

Chemistry and Physics of Petroleum.

186.* Elements of Vaporization. The Phase Rule. Part I. R. L. Huntington. *Refiner*, January 1940, **19** (1), 16–18.—The phase rule is defined and the general equation $F + P = C + 2$ is explained. To illustrate the application of the phase rule, examples are worked out in full for a steam boiler and a mixture of gases.

It is explained that this series of papers has been prepared for a three-fold purpose: (1) to provide the man in the plant or refinery, who has had a year or two of college work, with certain tools and methods needed in the solution of engineering problems; (2) to enable the graduate engineer to review some of the principles he learnt in college; (3) to give the plant man who is planning on returning to college or studying in

vocational classes a chance to acquire some skill and practice in making quantitative calculations. A. H. N.

187.* Can the Hydroxylation Theory of Combustion be Applied to Modern Furnaces? J. R. Darnell. *Refiner*, February 1940, **19** (2), 53–54.—The paper suggests that the answer to the title is "no," and further suggests that the question is worthy of research. The theory of hydroxylation assumes that there is a progressive oxidation of the hydrocarbons by intermediate steps, the first of which is the formation of the hydroxyl radical OH in combination with the carbon and hydrogen atoms to produce first an alcohol, then an aldehyde, and next an acid. The end-products, of course, are carbon dioxide and water vapour.

The chief criticism of this theory appears to be the fact that the experiments on which the theory is based were conducted at temperatures far below those operating in a modern commercial furnace. A. H. N.

188.* Partial Oxidation of Petroleum and Natural Gas. W. L. Faith. *Refiner*, March 1940, **19** (3), 68–72.—The present status of the partial oxidation of petroleum hydrocarbons is reviewed. The effect of the variables time, temperature, pressure, concentration, and catalysis on the reaction is emphasized. Problems involved in equipment design are also presented.

Of the processes being operated commercially, few operating details are available. One major oil company is manufacturing carload lots of methanol and formaldehyde by the oxidation of natural gas. Operating conditions probably include pressure in the neighbourhood of 250–350 lb./sq. in., elevated temperature, and a low oxygen-hydrocarbon ratio. Several metals and oxides, including platinum, are known to catalyze this reaction, but it is possible that the chemical nature of the surface is not nearly so important as time of contact.

Another commercial process is the oxidation of ethylene to ethylene oxide. Patent literature indicates that a catalyst consisting primarily of silver is used, that pressures up to 50 atmospheres, and temperatures ranging from 300° to 400° C. are employed.

In Europe, fatty acids capable of being converted into soaps are made by the oxidation of the heavier hydrocarbon fractions. Low-temperature liquid-phase processes are used both with and without catalysts. The products are converted into an inferior grade of soap. A. H. N.

189.* Elements of Vaporization and Condensation. Part II. R. L. Huntington. *Refiner*, March 1940, **19** (3), 80–84.—The application of phase-equilibria principles to the behaviour of a water–pentane mixture and mixture of two or more hydrocarbons under vaporization conditions is studied by means of hypothetical, constant-pressure, frictionless piston overlying such systems in closed cylinders.

Raoult's and Henry's Laws are studied and illustrated. The case of the exception of water and propane mixtures is cited.

Water is slightly soluble in practically all hydrocarbons. In the fractionation of propane a small amount of dissolved water is often found to be present. The removal of this water from the propane is required before it can be sold as domestic fuel, as the presence of water is apt to cause freezing in the gas-reducing regulators. Drying agents such as silica gel have been used for the dehydration of propane, but the most satisfactory method of water removal has been effected through fractionation. Although propane has almost 200 times the vapour pressure of water, dissolved water in propane does not behave according to Raoult's Law, but, on the contrary, the dissolved water proves to be more volatile than the propane. As a result the water is taken out overhead from the fractionating column. A. H. N.

190. *Elements of Vaporization and Condensation. Part III. R. L. Huntington. *Refiner*, April 1940, **19** (4), 125–126.—The calculation of evaporization losses from large atmospheric storage tanks is discussed. Vapour temperatures in a tank will often go as high as 30° or 40° F. above the air temperature on clear, sunny days when there is little wind. At night, however, the air and vapour temperatures will tend to approach each other, so that the vapour may be only 2–10° F. above the air temperature, early in the morning just before sunrise. The high vapour temperature

at noon day, or shortly thereafter, is the result of the conversion of radiant energy into heat energy on the surface of the tank, which may reach a temperature of 140–150° F.—some 20–30° F. higher than the vapour inside the tank. The loss of heat, by radiation and convection, from the tank to the cooler surroundings cannot begin to keep up with the rapid absorption of radiant energy from the sun when it is high in the sky.

The liquid in the tank picks up some radiant energy from the sun through the walls of the tank; however, the far greater mass and heat capacity of the liquid causes this phase to lag behind in temperature change. Consequently, the liquid in a tank may vary only 2° or 3° F. between day and night. Vaporization in the day-time tends to cool the liquid, and condensation of part of the gasoline vapour has a heating effect at night, both these factors tending to keep the liquid constant in temperature over the 24 hours.

Losses are computed for a typical example.

It has been found from experience, however, that breathing losses increase up to liquid withdrawal of approximately 10%, above which the losses are practically constant. This phenomenon is due to the fact that the air does not mix very readily with the vapour in tanks containing a small amount of liquid, since the vapour is usually 2–4 times as dense as the atmosphere. A. H. N.

191.* Deviation of Natural Gas from Boyle's Law. F. H. Dotterweich. *Refiner*, May 1940, **19** (5), 148–150.—The correction factor in compressing natural gas is given by the formula, $N = \frac{0{\cdot}154\,p(m + 4l + 3c + 0{\cdot}22a)}{1000}$ where N = deviation in per cent., p = pressure in lb./sq. in. gauge, m = per cent. methane, e = per cent. ethane, c = per cent. carbon dioxide, and a = per cent. air. It is suggested that gas volume obtained from flow measurements at high pressures be multiplied by a correction factor of the square root of $(1 + N/100)$; if the measurement is by a displacement meter, the correction factor is $(1 + N/100)$.

Deviation factors giving the deviation of the behaviour of natural gas from Boyle's Law are plotted on pressure-deviation factor graphs as isotherms at temperatures between 32° F. and 212° F. The graphs show maxima at nearly 160 atmospheres, coincide at nearly 480 atmospheres for all temperatures, and continue to yield decreasing values beyond.

Correction factors are also discussed at reduced pressures and temperatures and general graphs for PV/RT at various values of P_R show better agreement with the gas laws at values of T_R increase from 1, the critical temperature, to 1·70.

Methods of calculations and their range of applicability and limitations are illustrated by a numerical example. A. H. N.

192.* Elements of Vaporization and Condensation. Part IV. R. L. Huntington. *Refiner*, May 1940, **18** (5), 164–166.—Flash or equilibrium distribution, batch or differential vaporization, and combination flash and differential vaporization are discussed. An empirical relationship, such as the one which has been worked out for the flashing of crude oils, is needed for the simplification of calculations for stage separation, but to date no satisfactory correlation of this nature has been developed. In previous papers of this series the method of calculating the separation of two component mixtures of hydrocarbons has been explained. Although the same principles are involved in the handling of three or more hydrocarbons, the calculation requires far more labour, as the trial-and-error or successive-approximation method is the only feasible attack to make. A straightforward algebraic solution of a three-component mixture is possible, but it calls for a far greater mass of calculations than the trial-and-error method.

A method of conducting material balance is explained, and an example, worked out completely by trial and error, illustrates calculation of bubble point of a gas mixture of propane, and normal butane and pentane. A. H. N.

193.* Elements of Vaporization and Condensation. Part V. R. L. Huntington. *Refiner*, June 1940, **19** (6), 219–221.—The utility of phase diagrams in distillation studies is illustrated, and water, being a most commonly known fluid, is made the subject of detailed study as an illustration.

Graphs showing the isotherms, isochores, and isobars are given for water. However, the abscissa for the isotherms is marked "temperature" instead of "volume." The significance of the three diagrams and that of the triple point is briefly reviewed, and the three diagrams are combined in a solid P–V–T model. The application of the P–V diagram in power generation problems is indicated.

An interesting illustration of the principles involved is made by an example of gas-lifting water, under isothermal conditions, through a height of 55 ft., by a gas of a simple mixture of methane, ethane, and propane, and requirements of gas are calculated on the assumption of isothermal expansion and an efficiency of 40%. A. H. N.

194.* Mixed Catalysts. V. N. Ipatieff. *Refiner*, July 1940, **19** (7), 250–255.—Prof. Ipatieff reviews in this paper certain of his work and theories on the mechanism of catalysis, the rôle of promoters, and the action of poisons.

The necessity of hydrogen chloride in the alkylation of, say, benzene in the presence of aluminium or its chloride is attributed to the necessity of the formation of hydrogen aluminium chloride, which is the true catalyst of the reaction.

The well-known rôle of water, as postulated by Ipatieff and his co-workers, in the action of alumina on alcohols is reviewed.

The action of a mixed catalyst is similar to that of a promoter, in that it either improves the physical condition of the catalyst or evokes a new reaction which will help the other. Only small quantities are sometimes necessary to affect the rate of reaction. It is proposed to call the composition of maximum activity of a mixed catalyst the *eucoactive* composition.

The mechanism of poisoning is believed to be based on the fact that molecules of different chemical constitution than that of the catalyst will always be present in the catalyst—*i.e.*, a reduced metal catalyst will always contain the oxide, and *vice versa*. The introduction of a catalyst poisoner in negligible quantities can stop the action of a catalyst by weakening or paralyzing the action of the molecules producing a given process, in consequence of which fact the neighbouring molecules will not receive a sufficient amount of energy and the process will cease. A similarity from the animal kingdom is cited—a minute amount of poison will kill a large animal if a vital physiological process in a very limited place of the organism is stopped. Energy cannot be carried to other organs of the body.

An example is given from the inhibiting effect of a special mucus secreted by the gastric glands on the mixed catalyst existing in the stomachs of animals—pepsin and dilute hydrochloric acid—to illustrate the uniformity of laws governing catalytic reaction in the animal and vegetable as well as the mineral kingdom. A. H. N.

195.* Elements of Vaporization and Condensation. Part VI. R. L. Huntington. *Refiner*, July 1940, **19** (7), 256–259.—Three types of binary mixtures are considered in the study of their pressure–temperature–composition relationship: (1) mixtures in which two components are miscible in all proportions; (2) mixtures in which the two components are totally immiscible; and (3) mixtures which are miscible within certain ranges of composition but outside these ranges form two phases, each phase being a definite mixture of the two components.

The pressure–composition of each of the three types is illustrated graphically in the conventional manner, each case being studied by citing a typical example.

Maximum and minimum boiling-point mixtures are further studied and illustrated. A. H. N.

196.* Kinetics and Mechanism of Decomposition of Hydrocarbons. M. P. Eshevskaya. *Refiner*, August 1940, **19** (8), 264–267.—In a study of the kinetics of decomposition of lower paraffins under low pressures, it was shown in some individual cases that the reactions are retarded by the reaction products. In this study the inhibiting effect of certain unsaturated hydrocarbons on the decomposition of paraffin hydrocarbons, *iso*-octane being specifically studied, is reported for ethylene, propene, normal butene, *iso*butene, 2 : 2 : 4-trimethylpentene, bivinyl, *cyclo*hexene, and *iso*prene.

Di*iso*butene, normal butene, and ethylene exert no noticeable inhibition under atmospheric pressure on the decomposition of *iso*-octane.

*iso*Butene, propene, bivinyl, *cyclo*hexane and *iso*prene, on the other hand, greatly reduce the rate of reaction.

An increase in the concentration of propene or bivinyl, used as retarding agents, is established to result in raising the retarding effect at first rapidly and then more slowly.

The mechanism of the retarding action is explained on the basis that the average length of the chain in the decomposition of ethane is 100, and that certain of the free radicles combine with the retarding agent, thus reducing the length of the chain.

A. H. N.

197.* Elements of Vaporization and Condensation. Part VII. Distillation and Fractionation. R. L. Huntington. *Refiner*, August 1940, **19** (8), 287–290.—The fundamental principles involved in simple distillation and fractionation are outlined briefly. The advantages of the pipe-still over the shell-still are listed.

Bubble-plate fractionating columns are described in a general way, and the main points to bear in mind in designing the size, disposition, shape, and number of bubble caps, downspouts, weirs for overflow, etc., are given. The Souder–Mott–Brown formula for calculating permissible mass velocity of vapours in towers to avoid entrainment is given; *i.e.*:—

$$W = C[d_2(d_1 - d_2)]^{\frac{1}{2}}.$$

However, no values are given for the constant C to be used in the formula. References are included.

Two systems for fractionating a mixture of propane, normal butane, and normal pentane are contrasted, and the relative merits of each are used as a basis of general discussion on layout of columns used in series.

Simple calculations on pressure distillation and stabilization are included in the discussion.

A. H. N.

198.* Viscosity and Constitution. G. Hugel. *Refiner*, August 1940, **19** (8), 294–296.—There is an important difference between chemical reactions and flow phenomena: in the chemical reaction only those collisions of molecules enter the picture which have been energetically activated, whilst in flow phenomena similar collisions have to be studied, but the molecules almost always carry a high energy level. It appears, then, that perhaps important characteristics of chemical constitution can have little or no bearing or influence on the viscosity of liquids.

This hypothesis is illustrated by plotting a mathematical function of viscosity of three liquids which are extremely different from a chemical point of view, dihydrodi-*iso*amyl anthracene, butandiol, and *n*-octane, and obtaining one curve for all three. The function was $\log \eta - a$ plotted against $T - b$, where η is viscosity, T is absolute temperature, and a and b are constants.

The simple exponential formula connecting viscosity and temperature (so-called Andrade Equation) is reviewed, and a linear relationship between the heat of activation of viscosity and the constant A is obtained for several substances which appear to yield a line common to all.

Dunstan's logarithmic law on the additivity of $\log \eta$ is studied in connection with the ketones which behave chemically as an associated liquid, and yet by viscometric studies according to Dunstan's law gives the same log increment for CH_2 as unassociated liquids. The behaviour of alcohols and glycol is studied.

A. H. N.

199.* Elements of Vaporization and Condensation. Part VIII. Fractionator Design. R. L. Huntington. *Refiner*, September 1940, **19** (9), 354–358.—Laboratory fractionation of hydrocarbon gases is discussed both for low-temperature fractionation of natural gas and for ordinary high-temperature fractionation of heavier fractions. The difference in the boiling-point curves as obtained by the A.S.T.M. distillation apparatus and a true boiling-point column is briefly discussed and illustrated.

As an example, the fractionation of a binary mixture of simple hydrocarbons is studied. McCabe–Thiele graphical method of evaluating the number of theoretical plates necessary is used to show the difference of high-pressure and atmospheric distillation processes, but the method is not sufficiently described for one interested in the "elements" of the subject. Mention is made of Sorel's algebraic method. Previous parts of the paper, however, have already dealt with the fundamental physical

relationships between the variables of temperature, pressure and composition. [See *Ref.*, January–August, 1940, **19** (1–8).] A. H. N.

200.* Studies on the Separation of Paraffin Waxes. Part II. Phase Relationships. M. F. Sawyer, T. G. Hunter, and A. W. Nash. *J. Inst. Petrol.*, September 1940, **26** (203), 430.—Experimental results are reported for single- and multiple-stage separation of paraffin wax, after equilibrium has been attained between solid and liquid layers, and a theory is outlined for the ideal or infinite-stage fractional melting processes. A. H. N.

201.* Synthesis and Properties of Mono-Normal-Alkyl-Benzenes. Part I. G. Shen, T. Y. Ju, and C. E. Wood. *J. Inst. Petrol.*, October 1940, **26** (204), 475–487.—After critically examining the principal available methods for preparing *n*-alkylbenzenes, it is concluded that Friedel and Crafts' reaction is the best method for obtaining large quantities of hydrocarbons. Palladium is used for hydrogenating the alkyl aryl ketone which is the resultant of the Friedel–Crafts reaction. Both theoretical and experimental work is detailed, but Part I is devoted exclusively to theoretical considerations. A. H. N.

202.* Synthesis and Properties of Mono-Normal-Alkyl-Benzenes. Part II. T. Y. Ju, G. Shen, and C. E. Wood. *J. Inst. Petrol.*, November 1940, **26** (205), 514–531.—In this part of the paper the preparation, purification, and the properties are reported both for the intermediate ketones and for the corresponding hydrocarbons, in the synthesis of *n*-alkylbenzenes by Friedel and Crafts' reaction between benzene and corresponding acid chlorides to yield *n*-alkylphenyl ketones, which are reduced, by two methods, to the hydrocarbons. Large quantities have been prepared and their properties reported both as given in the literature and from the authors' experiments. A. H. N.

203.* Mechanism of Aromatization and Xylene Thermal Isomerization. A. F. Dobryanskii and F. Ya Saprykin. *Oil Gas J.*, 8.8.40, **39** (13), 48.—The yield of toluene and the structure of the xylene isomers formed by the pyrolysis of the pure xylenes at different temperatures have been examined. It has previously been shown that the pyrolysis of xylene at higher temperatures gives a higher yield of total xylenes and a greater preponderance of *m*-xylene over *o*-xylene than that at low temperatures. It is possible that this is due to isomerization of other xylenes to *m*-xylene at high temperatures. Pyrolysis of the three pure xlyene isomers was carried out in a porcelain tube at 700°, 730°, 750°, and 770° C., the yields of toluene from *o*-xylene increasing from 4·6% to 12·8% at increasing temperatures, that from *p*-xylene increasing from 2·1% to 13·3%, and that from *m*-xylene increasing from 1·7% to 15·4%. The xylene isomers formed (or unaltered) were separated, and it was found that *o*-xylene tended to form *m*-xylene in increasing quantities at high temperatures (5–38·2%), but relatively little *p*-xylene (traces to 10·5%). *p*-Xylene produces no *o*-xylene and only 1·3–7·7% *m*-xylene. *m*-Xylene is the most stable isomer and produces no *o*- or *p*-xylene on pyrolysis, the main products being toluol and condensable hydrocarbons.

From the data presented no conclusions can be reached as to whether *o*- and *p*-xylenes are subject to decomposition while in the *m*-xylene stage. It seems probable that decomposition and isomerization are simultaneous but independent reactions. C. L. G.

204. Cyclization of Dienynes. X. The Dodecahydrophenanthrone Obtained from Di*cyclo*Hexenylacetylene. C. S. Marvel, D. E. Pearson, and R. V. White. *J. Amer. chem. Soc.*, 1940, **62**, 2741–2743.—The ketone obtained by the cyclization of di*cyclo*hexenylacetylene with sulphuric acid has an α-, β-unsaturation as suggested by Linstead and Walpole. T. C. G. T.

205. Tertiary Naphthenic Acids. I. Synthesis of 1 : 2 : 3 : 3-Tetramethyl*cyclo*pentanecarboxylic Acid from Camphor. B. Shive, J. T. Horeczy, and H. L. Lochte. *J. Amer. chem. Soc.*, 1940, **62**, 2744–2746.—During research on the acidic constituents

of petroleum, appreciable amounts of materials have been encountered which are not esterifiable by alcoholic hydrogen chloride. Since little is known regarding tertiary naphthenic acids, the work on such unesterifiable materials has been hampered.

1:2:3:3-Tetramethyl*cyclo*pentanecarboxylic acid has been synthesized from camphor and found to be different from the $C_{10}H_{18}O_2$ acid previously isolated. T. C. G. T.

206. Aromatic *cyclo*Dehydration. VII. Phenanthrene. C. K. Bradsher and R. W. Wert. *J. Amer. chem. Soc.*, 1940, **62**, 2806–2807.—Aromatic *cyclo*hydration or cyclization in which the elements of water are eliminated from a compound with the establishment of a new aromatic ring has been further developed and used in the synthesis of phenanthrene. T. C. G. T.

207. Catalytic Dehydrogenation of Alcohols in the Liquid Phase Using Ethylene as a Hydrogen Acceptor. W. Reeve and H. Adkins. *J. Amer. chem. Soc.*, 1940, **62**, 2874–2876.—Alcohols of four or more carbon atoms (*e.g.*, butyl, alcohol, or heptanol) may be dehydrogenated to aldehydes or ketones on the liquid phase. The reaction is carried out under 50–150 atms. ethylene, which latter accepts the released hydrogen. The reaction occurs at 280° C. The best catalyst is a mixture of copper, zinc, nickel, and barium chromites, but the reaction occurs with copper chromite alone. Barium seems to have a notable effect on retaining the activity of the catalyst, whilst zinc and nickel prevent polymerization of the aldehydes. T. C. G. T.

208. The Action of Elementary Fluorine on Organic Compounds. IX. The Vapour Phase Fluorination of Methane. E. H. Hadley and L. A. Bigelow. *J. Amer. chem. Soc.*, 1940, **62**, 3302–3303.—The vapour-phase fluorination of methane over a copper-gauze catalyst has been studied. Conditions were established when the proportion of products formed other than CF_4 could be increased to a maximum of 45 liquid vol.-% of the total condensate.

The products of fluorination contained all the fluoromethanes, C_2F_6, and C_3F_8. T. C. G. T.

209. Chlorofluoropropanes. E. J. McBee, A. L. Henne, H. B. Hass, and N. Elmore. *J. Amer. chem. Soc.*, 1940, **62**, 3340–3341.—$CH_3CF_2CH_3$, prepared from $CH_3C\,Cl_2CH_3$, has been chlorinated to produce several chlorofluoropropanes, including $CH_2Cl\,CF_2C\,Cl_3$ and $CH_2Cl\,CF_2CF_2Cl$, which were more pure than previously prepared compounds. New compounds were prepared by fluorinating $CH_2Cl\,CF_2C\,Cl_3$ to $CH_2Cl\,CF_2CF\,Cl_2$ and to $CH_2Cl\,CF_2CF_2Cl$ and by chlorinating $CH_2Cl\,CF_2CF_2Cl$ to $CH\,Cl_2CF_2CF_2Cl$ and to $C\,Cl_3CF_2CF_2Cl$. T. C. G. T.

Analysis and Testing.

210. Reflux Regulator and Head for Laboratory Rectifying Columns. F. D. Rossini and A. R. Glasgow, Jr. *Bur. Stand. J. Res. Wash.*, 1939, **23** (4), 509–513.—Although a number of reflux regulators and heads for laboratory rectifying columns has been described in the literature, none appears to fulfil all the special requirements arising in connection with the work of the A.P.I. Research Project 6 at the National Bureau of Standards.

These special requirements are that the device should (*a*) have a non-lubricated glass valve, (*b*) utilize a minimum of height above the column proper and permit the use of as long a rectifying section as possible, (*c*) provide for a substantially constant rate of removal of distillate for each setting of the valve, (*d*) provide for estimation of the throughput and reflux ratio, (*e*) provide space for a thermometric device, and (*f*) have a flexible metal partition for permitting distillation at pressures below or above the prevailing atmospheric pressure.

This paper describes an apparatus that possesses the above properties. D. L. S.

211.* Petroleum Solvents for Paints Compared by New Solvency Tests. S. S. Kurtz, Jr. *Nat. Petrol. News*, 24.7.40, **32** (30), R. 270–R. 273.—Increasing interest in the use of petroleum solvents in the paint industry has disclosed deficiencies in the nitrocellulose dilution ratio and the Kauri-gum butanol test. The viscosity of a dispersion

of a resin in a petroleum solvent has been shown to be a sound and reliable guide to solvent power.

$$\text{Resin Solvency (R.S.)} = \frac{\text{viscosity of } X\% \text{ Resin in Standard Solvent}}{\text{viscosity of } X\% \text{ Resin in Solvent on Test}}.$$

The preparation of resin solutions is a time-consuming operation, and time is saved by the use of a graphical method based on a correlation between R.S. and specific gravity, refractive index at 20° C., and the 50% A.S.T.M. end-point. The tests are reliable only for two-fold systems, simple solutions of one resin in a spirit. Current investigations are expected to extend the application of the tests to systems in which a third principle is present. H. G.

212. Significance of Doctor Test for Gasoline Found Negligible. J. Happel and S. P. Cauley. *Nat. Petrol. News*, 7.8.40, **32** (32), R. 284–R. 290; *Refiner*, June 1940, **19** (6), 205–208.—The paper comprises a critical discussion of the significance of the doctor test as a gasoline specification item from the points of view of both consumer and refiner. Data are presented to show that although from the consumer's point of view the test is used to control odour, in many cases the two factors are unreliably related. The practical limit of mercaptan concentration, when odour only is the criterion, is usually greater than that demanded by the sensitivity of the test. From the refiner's point of view it is suggested that the gain from the standpoint of odour is often outweighed by a quality loss in the shape of a reduced octane number after treatment. It is argued that in the interests of all concerned the mercaptan concentration of a finished gasoline should be controlled by considerations of economics, and should not be dependent on an arbitrary test. It is concluded that a greater consciousness of properties of more significance than that of odour and a growing realization of the lack of its significance should combine to eliminate the doctor test from gasoline specifications. H. G.

213.* Reduction Chart for the Stormer Viscometer. H. T. Byck. *Oil Gas J.*, 8.2.40, **38** (39), 40.—In the measurement of the viscosities of drilling muds by the Stormer instrument the rotor speed is fixed at 600 r.p.m. and the driving weight necessary to produce this speed is determined. This driving weight is converted into absolute viscosity by a calibration chart obtained by measuring a series of glycerine solutions of known viscosity in the same instrument. The rotor speed is adjusted by variation of the driving weight until 100 revolutions take place in exactly 10 sec. In practice this is tedious, and a means of arriving at the value for 10 sec. by interpolation from values on either side of the correct one has been devised. Provided the times for 100 revolutions are in the one case not less than 8 sec. and in the other not more than 12 sec., the curve driving weight against time is a straight line. A chart on this basis is provided and its application illustrated. R. J. E.

214.* Vapour Bomb Connection Saves Pressure Gauges. D. Attaway. *Oil Gas J.*, 1.8.40, **39** (12), 41.—In carrying out the Reid Vapour-Pressure Test (A.S.T.M. D. 323–37 T) the air-chamber and gauge are subjected to numerous and vigorous shakings, resulting in damage to the spring-gauge mechanism and necessitating frequent recalibration and repair. A description is given of a needle-valve and collar which may be inserted between the air-chamber and gauge, thus allowing the gauge to be removed before shaking. Check tests against a standard assembly agree to within 0·1 lb. C. L. G.

215.* Calculating Gasoline Octane Rating from Gravity and A.S.T.M. Distillation. R. B. Cox. *Refiner*, February 1940, **19** (2), 31–36.—The paper presents methods of calculating the octane rating of any gasoline by using only its A.P.I. gravity and A.S.T.M. distillation. All gasoline samples are subjected to at least these two tests, even in control work, so that the calculation proposed here requires no tests other than those that are made in any case. This obviates the objection that has been raised to other methods of octane number predetermination. Moreover, these two basic tests are simple, reproducible, accurate, require no complicated apparatus, and may be

determined by one operator in a total elapsed time of 35 min. In fact, with a little experience one operator can run three distillations simultaneously.

The basis of this correlation is the fact that when the boiling point is plotted against gravity for 180 hydrocarbons generally found in straight-run and cracked gasolines, the types fall in fairly well-defined areas, with the saturated straight-chain paraffins forming the upper boundary of the top region, and the aromatics the lower region. The rest of the development of the charts and arguments are empirical.

It is pointed out that the charts are naturally no more accurate than the test data. It is absolutely imperative that the distillation be run exactly to A.S.T.M. specifications. Also, the distillation must be run immediately after the gravity is determined. Allowing the sample to stand for even a few minutes after the gravity is taken before running the distillation is a common source of error, owing to evaporation at room temperature of the lighter fractions. Such evaporation changes the distillation curve, particularly the 10% point. A. H. N.

216.* Determination of Tetraethyl Lead in Gasoline. G. Calingaert and C. M. Gambrill. *Refiner*, February 1940, **19** (2), 58–60.—Tetraethyl lead is determined quantitatively by refluxing the gasoline with concentrated hydrochloric acid, extracting the lead chloride with water, and determining the lead found by any of the standard methods.

A table indicates that the new method yields results with a mean error of only − 0·012 ml. of tetraethyl lead/gall. of gasoline, as against − 0·054 for the bromination method, the improvement being particularly noticeable in the case of cracked gasolines. Furthermore, the precision of the new method is greater than for the bromine method, the upper limit for the variation between laboratories being 0·050 ml. of tetraethyl lead/gall. of gasoline by the new method, as compared with 0·075 by the bromine method. A. H. N.

217.* New Firing Time Test. J. DeMent. *Refiner*, August 1940, **19** (8), 282–284.—It was noted that many organic inflammable liquids, when ignited, burned with a time characteristic for each sample. Further, when a standard procedure was followed, the flames, deposits, residues, colours, types, and heats of flames were also characteristics of the liquid burning. Thus a new test is outlined where a measured quantity of liquid is slowly poured into a burner, ignited, and the time it takes to burn completely is noted with a stop-watch.

Experimental procedure and standardized apparatus and technique are detailed. A table gives characteristics for various liquids, the firing time period varying from 39·1 sec. for a sample of methanol, to 95 sec. for a sample of gasoline under standardized conditions. To illustrate the repeatability and precision of the test for liquids requiring rapid technique 20 test results are reported for a sample of methanol, the average being 45·0 sec., with a minimum value of 41·6 sec., and a maximum of 47·2 sec.

A modified test is suggested for liquids and solids which do not burn easily, which test uses a solvent for the liquid or solid being studied.

A scheme of fire time determination in which various properties of the flame are noted both qualitatively and quantitatively is detailed, and a list of possible applications and modifications of the test ends the paper. A. H. N.

Motor Fuels.

218.* High Anti-Knock "Safety" Aviation Fuel. M. G. van Voohis. *Refiner*, January 1940, **19** (1), 19–21.—It seems that the solution of the problem of aviation fuels and their better utilization in the modern multi-cylinder engine is mostly viewed in relation to replacing the carburettor with a device for direct injection.

A saving of 5% gasoline is secured by the use of direct injection of the fuel, this being quite appreciable in the field of aviation mechanics. Another advantage is in testing work where the multi-cylinder engine can be easily replaced by a single-cylinder engine, lowering the cost and simplifying the test procedure.

The direct-injection motor is manufactured extensively in Germany, and its use will no doubt result in the utilization of a far less volatile fuel than gasoline, resulting in the wide adaptation of this type of motor. The motor functions at once with any

setting of the injection pump, which is of paramount value in airplane flights. From a military point of view, it can be mentioned that this motor allows the pilot to approach his objective in gliding formation absolutely silently once he has attained a predetermined height. It is also important in similar type planes to point out the great fire hazard when using very volatile fuels, their hazardous storage in the supply tanks, and the use of complicated feed systems. The use of "internal cooling" is more easily obtained, since regulation of the injection is easier and safer when controlling the single air inlet.

The idea of using safety fuels to increase the safety of airplane operations is so important as to necessitate the most thorough scientific and mechanical investigations. It is of course understood that such safety fuel will be a highly efficient and otherwise scientifically refined product showing no lowering of engine efficiency. Tests and aspects of safety in using these fuels with low fire hazards are discussed briefly.

A. H. N.

219. Patent on Motor Fuel. A. R. Goldsby. U.S.P. 2,221,165, 12.11.40. Appl. 15.10.40. Conversion of lower-molecular-weight hydrocarbons into higher-molecular-weight hydrocarbons. Straight-chain and branched-chain paraffinic hydrocarbons are subjected to the action of chromic acid and a metallic halide at a sufficiently high temperature to effect a substantial amount of dehydrogenation and alkylation to produce anti-knock hydrocarbons within the motor-fuel boiling range. H. B. M.

See also Abstracts Nos. 212 and 215.

Diesel, Gas and Fuel Oils.

220. Patents on Gas, Diesel and Fuel Oil. H. Rupp. E.P. 528,093, 22.10.40. Appl. 27.4.39. Preparation of a colloidal fuel in which the solid particles are in very stable suspension in the liquid fuel. The suspension, or first the liquid fuel and then the suspension of coal dust, is maintained under vacuum and the gas injected by means of an atomizer. Thereafter the suspension is allowed to return to normal pressure.

D. E. Badertscher and M. S. Altamura. U.S.P. 2,218,447, 15.10.40. Appl. 15.12.38. Preparation of a diesel fuel oil in which is incorporated a small proportion of the aliphatic thiamine obtained by reacting a primary aliphatic amine with sulphur dichloride. H. B. M.

Lubricants and Lubrication.

221.* Non-Fluid Lubrication. Part III. S. Kyropoulos. *Refiner*, March 1940, **19** (3), 85–92.—The various physico-chemical factors are discussed, determining the behaviour of bearing metals in non-fluid lubrication under the influence of local high temperatures and chemical reactions with the lubricant which are liable to occur. Journal polish is in general to be considered both as a mechanical protection against excessive cold work by greater smoothness, and as a physico-chemical protection by a protective anti-welding oxide layer. The coefficient of kinetic friction will be that of the oxidized metal.

A new theory of bearing metals is presented, explaining the mechanical part played by the various constituents of a composite bearing metal. The load-carrying capacity of a simple structure is calculated by stress analysis. The theory, derived from observation, provides a simple rule for the selection of bearing alloy components and indicates general rules for the relative particle size.

In a well-composed bearing metal for high speed and temperature it is the soft component which directly carries the load, because of its higher thermal expansion. Due to the part played by volume expansion, the relative particle size of the constituents determines frictional and seizure properties. The number of metals with outstanding thermal expansion is limited to Cd, Pb, Sn, Al, and Ag. Their melting points are upper limits of "high-spot" temperatures, and consequently limit possible physico-chemical reactions—*e.g.*, diffusion-seizure with the journal. Cd, Pb, and Sn are, for such reasons, the easiest to handle. Because of their low yield and melting points, their friction must necessarily be low.

Fatigue resistance and mechanical strength increase, in a general way, with the melting point. For the same reason the work of deformation increases, as does the kinetic friction—comparing *e.g.* Sn and Al—because there is no kinetic friction without cold work and wear. It is for this reason that any pure high-melting metal must tend to "grip" any journal under certain conditions of clearance and temperature, no matter whether this "gripping" is accompanied by true seizure (welding, diffusion) or not.

In connection with fatigue phenomena the physical fundamentals of crystal strength and Griffith's theory of rupture are briefly discussed with regard to possible effects of differential expansion on the intercrystalline stresses. The problem of intracrystalline reinforcement is briefly discussed, and a possible attack of the problem of reinforcement against fatigue from the lubrication angle is suggested. A. H. N.

222.* Effect of Engine Metals on the Deterioration of Motor Oil. B. F. Downing, G. E. Holbrook, and J. H. Fuller. *Oil Gas J.*, 15.6.39, **38** (5), 70.—The catalytic oxidation effect of various metals on transformer oils and lubricating oils has been studied by laboratory tests (bibliography given), but no information has been published on the effect of engine metals, as determined in full-scale engine tests. To obtain these data tests were carried out on a 6-cylinder 1936 Chevrolet engine, the effect of the different metals present being separated by making tests before and after selected surfaces had been protectively lacquered by the resinous film from lubricating oil at high crankcase temperatures. The effect of iron was maximized by cleaning the engine in 5% trisodium phosphate solution, and that of bearing metals by using new bearings. Oil samples were drawn from the sump after 10 min., 1 hr., 3 hrs., and 4 hrs., and analysed for (1) total sludge (A.S.T.M. naphtha insoluble), (2) asphaltenes (total sludge soluble in chloroform), (3) ash, and (4) iron. From the total sludge, ash is deducted, giving hydrocarbon sludge, allowance being made in determining the final sludge figure for the sludge in the samples taken. It is shown that the total catalytic effect of crankcase iron is much greater than that of Cu–Pb, Ag–Cd, and Babbitt metal in connecting rod bearings. Of the bearing metals Cu–Pb is the most active, with Babbitt and Ag–Cd following in that order. The addition of 0·5% of phosphorus additive (80% tricresyl phosphate and 20% tributyl phosphite) reduced total hydrocarbon sludge by 51·5/83·1% and connecting-rod bearing wear by 52·8/96·5%, iron being still the predominating influence, and gave uniformly lower oil deterioration. It is concluded that approximately two-thirds of the oil oxidation and deterioration in a clean or new engine is due to catalysis by engine metals. The effect of the phosphorus additive is attributed to retardation of solution of metal in the oil and inhibition of the catalytic effect of the metal on the oxidation of the oil. This is particularly the case with new copper lead bearings until they acquire a lacquered surface.
C. L. G.

223.* Piston Deposits, Ring Sticking, Varnishing and Ring Clogging. W. A. Gruse and C. J. Livingstone. *J. Inst. Petrol.*, September 1940, **26** (203), 413–429.—It is found that engine-varnishing, ring-sticking, and oil-ring clogging are more or less closely related. Oxidation of oil, chiefly in the crankcase, to unstable products, followed by the decomposing of these products at hot points in the engine, play an important part in all three. Cooling of crankcase oil is strongly advocated.
A. H. N.

224. Patents on Lubricants and Lubrication. E. A. Evans and C. C. Wakefield & Co., Ltd. E.P. 527,695, 15.10.40. Appl. 29.12.38. Improvements in extreme pressure lubricants comprising a mineral oil and a chlorine-containing naphthalene derivative. In this case the sole chlorine-containing naphthalene derivative consists of a minor proportion of naphthalene tetrachloride dissolved or suspended in the lubricating oil. The resultant product has a high film-rupture strength, and is accordingly particularly useful for the lubrication of moving parts in internal-combustion engines.

Armour & Co. E.P. 528,096, 22.10.40. Appl. 27.4.39. Improvements in the preparation of extreme-pressure lubricants composed of a lubricating agent to which has been added an alkyl thioamide to impart the desired characteristics.

Hilliard Corp. E.P. 529,209, 15.11.40. Appl. 24.5.39. Apparatus for purifying used lubricating oils. A filter is arranged to discharge the filtered oil into a vapourizing chamber containing a heated member formed with a number of comparatively shallow channels combining to form a tortuous path along which the oil must flow in a relatively thin stream before escaping from the chamber. The heated member is so arranged that the oil is heated prior to its passage through the filter, and the said chamber is connected to a source of suction which facilitates liberation of contaminating volatile constituents from the heated oil.

R. Rosen. U.S.P. 2,216,752, 8.10.40. Appl. 3.4.37. Preparation of a petroleum lubricating oil suitable for use at high temperatures and containing as an oxidation inhibitor a small amount of an oil-soluble compound with an aromatic nucleus.

B. H. Lincoln and W. L. Steiner. U.S.P. 2,217,173, 8.10.40. Appl. 19.2.36. Preparation of a high-film-strength lubricating oil consisting of a major proportion of hydrocarbon oil, 0·5–10% by weight of an aliphatic ester and 0·001–1% by weight of pinene.

W. G. Horsch. U.S.P. 2,217,368, 8.10.40. Appl. 12.3.38. Method of removing low-temperature sludge from dielectric mineral-oil compositions by adding thereto a substance selected from the group consisting of diphenyl and diphenyloxide.

F. Rostler and V. Mehner. U.S.P. 2,217,919, 15.10.40. Appl. 25.5.39. Production of a viscous mixture of unsaturated hydrocarbons containing 90% carbon and 10% hydrogen. The composition boils between 150° and 360° C., at 12 mm. Hg absolute pressure.

B. M. Lincoln, W. L. Steiner, and J. D. Byrkit. U.S.P. 2,218,132, 15.10.40. Appl. 2.5.38. Preparation of a lubricating-oil composition consisting of a major proportion of a hydrocarbon oil and from 0·05 to 25% of a sulphurized substantially pure olefin.

E. W. Fuller. U.S.P. 2,218,283, 15.10.40. Appl. 8.3.39. Preparation of a stabilized mineral-oil composition consisting of a highly refined viscous oil and a minor proportion of a mercapto-benzo-thiazole.

J. G. McNab and W. T. Watkins. U.S.P. 2,218,618, 22.10.40. Appl. 25.2.39. Preparation of an improved lubricant consisting of a mineral lubricating oil and a polyvalent metal soap of substantially non-distillable organic acids.

C. M. Loane and B. H. Shoemaker. U.S.P. 2,218,918, 22.10.40. Appl. 31.8.36. Preparation of a lubricating oil to which has been added a substantial amount of an alkyl thiocyanate having 8 to 14 carbon atoms in the alkyl radical.

F. R. Moser and M. C. Tuyn. U.S.P. 2,219,164, 22.10.40. Appl. 16.3.36. Preparation of an extreme-pressure lubricant consisting of a substantial quantity of mineral oil and a small proportion of a compound of the formula $R(SO_2X)m$, wherein R is an aliphatic radical, m is one or two, and X is a halogen.

R. C. Moran. U.S.P. 2,220,941, 12.11.40. Appl. 4.2.39. Preparation of a stabilized mineral-oil composition consisting of a viscous mineral-oil fraction having incorporated therein a minor proportion of a dimercaptyl diethyl ether in an amount sufficient to inhibit the deleterious effect of oxidation on the oil.

C. M. Loane and B. H. Shoemaker. U.S.P. 2,220,970, 12.11.40. Appl. 18.12.39. Preparation of a lubricant containing about 0·05–10% of an organic compound selected from the group consisting of (1) pseudo-thiourea derivatives and (2) the condensation products of thioureas and mustard oil.

C. T. Anné, H. I. Wilson, and W. C. Patterson. U.S.P. 2,221,161, 12.11.40. Appl. 25.8.38. Method of preparation of a lubricating oil suitable for use as cylinder stock, substantially free from asphaltic and acidic constituents, and having a desirable green cast, from reduced naphthene base crude oil.

H. V. Ashburn and W. G. Alsop. U.S.P. 2,221,162, 12.11.40. Appl. 6.8.38. Preparation of an oil for lubricating the bearings and cylinders of internal-combustion engines. The composition comprises a mineral lubricating oil within the motor-oil

viscosity range, 0·01–2·0% of a phosphatide to inhibit bearing corrosion and lacquer formation, and less than 1% of an emulsion preventing agent.

P. J. Wiezevich. U.S.P. 2,223,473, 3.12.40. Appl. 16.10.37. Preparation of a lubricating composition consisting of a petroleum lubricating oil and 0·5–30% of a ricanic metal soap soluble in the lubricating oil.

B. H. Lincoln, W. L. Steiner, and G. D. Byrkit. U.S.P. 2,223,766, 3.12.40. Appl. 2.2.40. Preparation of a lubricant consisting of a hydrocarbon oil intimately admixed with 1–10% by weight of a halogenated, aromatic ketone.

N. E. Peery. U.S.P. 2,223,793, 3.12.40. Appl. 14.11.38. Preparation of a lubricating composition consisting of a mineral oil and an amount sufficient to impart extreme pressure properties of a compound of the structure

$$\begin{matrix} R_1 \\ R_2 \\ R_3 \end{matrix} \!\!\rangle C - X - Y$$

R_1, R_2, and R_3 represent aryl radicals, X is an element selected from the group consisting of oxygen and sulphur and Y is a phosphorous halide radical containing 2 halide atoms attached to the phosphorous.

S. Musher. U.S.P. 2,223,941, 3.12.40. Appl. 29.11.39. Method of improving lubricating oils by decreasing sludge formation and tendency to cause corrosion of metal surfaces. The oil is reacted with a relatively small amount of combination of lethicin and a phosphite ester at a temperature above 350° F. H. B. M.

Asphalt and Bitumen.

225.* Continuous Automatic Blending for Cutback Asphalts. Anon. *Refiner*, August 1940, **19** (8), 261–263.—A description is given of a continuous automatic blending plant the capacity of which is 500 brl./hr. for blends which may range from 95% asphalt and 5% solvents to 50% of each. A single adjustment, maintaining the percentage of solvent in the final product, is sufficient to give any of twelve cutback asphalts continuously and without material deviation.

The plant is essentially composed of two units: a mixing unit and a solvent metering unit which is, in effect, a displacement meter which measures the quantity of solvent introduced into the asphalt upstream from the blending and mixing meter. An adjusting device on the solvent metering unit is set to adjust the ratio of solvent to the finished cutback. The operation and method of adjustment of the plant are detailed.

As solvent and asphalt are mixed under pressure in a closed system, foaming and loss of light fractions are avoided. When the correct proportions have been ascertained, and the plant set to deliver the required quantity of solvent, there appears to be but a slight deviation from specifications at the delivery end of the pipe line. A table giving data of a typical cutback illustrates this statement. A. H. N.

226. Road Oil Sales Increase 5% in 1939. R. R. Sayers. U.S. Dept. of the Interior, Bur. Mines, Mineral Market Reports, M.M.S. No. 851.—The report gives figures for refinery sales of road oil in the United States during 1939 and indicates an increase of 5% over the total for 1938. This was largely due to increased construction of oil-treated macadam, gravel, and sand-clay highways. Nevertheless, owing to lower prices, the value at the refineries of sales of road oil decreased by 11% during this period. Of the 8,108,400 brl. of road oil sold in 1939, only 293,100 brl. were made from foreign petroleum, imported chiefly from Venezuela and Mexico.

In 1939, 7,868,000 brl. of road oil were produced in United States refineries, as compared with 7,788,000 brl. in 1938. This output was increased by 1,222,700 brl. of other products, chiefly fuel oil, transferred to road-oil stocks. Thus, stocks of road oil and transferred oil increased by 22,000 brl. during 1939, as compared with an increase of 13,000 brl. during 1938. H. B. M.

227. Patents on Asphalt and Bitumen. K. Dammann. E.P. 527,816, 16.10.40. Appl. 21.3.39. Production of a bituminous road surface which, owing to the presence of numerous fragments of stone chippings, is extraordinarily rough, but in which the chippings are so firmly embedded that they cannot be torn out by traffic. The surface is effected by consolidating the chippings simultaneously with a sand-like asphalt mass or bituminous plastic layer by means of a consolidating implement, the operating face of which is fitted with a yielding layer of rubber. Thus the chippings become firmly anchored in the asphalt mass and at the same time project above its surface.

N.V. De Bataafsche Petroleum Maatschippij. E.P. 528,653, 4.11.40. Appl. 11.5.39. Manufacture of asphalt from products containing both asphalt and paraffin wax, and which have been obtained in the straight-run distillation of mineral oil. The products are first heated above the temperature at which disruption of dissolved molecular paraffin-wax aggregates occurs, subsequently cooled and deasphaltized within about 1 hr. of cooling below the critical disruption temperature, with the aid of said hydrocarbons at a temperature above that at which the paraffin wax begins to settle out.

A. B. Brown, F. C. Croxton and B. Ginsberg. U.S.P. 2,217,727, 15.10.40. Appl. 9.6.38. Method of obtaining high-melting point asphalt and bright stock from mixed-base crude residua.

A. P. Anderson. U.S.P. 2,223,776, 3.12.40. Appl. 21.10.38. Manufacture of asphalt having a high viscosity at elevated temperatures and good ductility at low temperatures. An asphaltic bituminous material is blended with a hydrocarbon material having a viscosity not less than 600 sec. (Saybolt) at 275° F., and a viscosity-gravity constant above 0·870. The hydrocarbon material is at least 95% soluble in 86° β naphtha. H. B. M.

Special Products.

228. Naphthenic Acids in Specialty Formulas. B. Levitt. *Chem. Industr.*, 1940, **47** (2), 166.—Although naphthenic acids derived from petroleum sludges have not as yet been completely isolated and identified, they have already found extensive use in the manufacture of soaps, paints, fungicides, etc. Based on a yearly world production of 200 million tons of petroleum and an average of 0·1% content of naphthenic acids, there is potentially available for recovery 200,000 tons of acids per year. In the U.S.A. the greater part of the naphthenic acids used are converted into metallic naphthenates for use as paint dryers, whilst in many European countries where fats are scarce these acids are used to a certain extent in the manufacture of soap. This article briefly describes the methods of recovery and properties of naphthenic acids, together with the preparation and uses of the metallic naphthenates. B. M. H. T.

229.* Petroleum Sulphonic Acids. S. Pilat and J. Sereda. *Refiner*, February 1940, **19** (2), 50–52.—From the products of interaction of sulphuric acid with mineral oils, sulphur derivatives of phenols occurring in crude oils were isolated for the first time. After splitting off the sulpho group from the phenolsulphonic acids, phenols were obtained having a molecular weight of about 260 and an empirical formula $C_{17}H_{25}OH$.

It was shown that the colour reaction of iron petroleum-sulphonates is due to the presence of petroleum phenolsulphonic acids for which it is characteristic.

Iron salts of petroleum phenolsulphonic acids are soluble in organic solvents, producing an intensive blue or green colour. Water-soluble mineral salts, in solid form or in the form of aqueous solutions, bring about a disappearance of the colour. Likewise, the effect of temperature or of traces of water is to bring about a disappearance of the colour or its reappearance.

Some changes observed in the iron salts of petroleum phenolsulphonic acids can be explained by the action of the hydroxyl group in the reaction with ferric chloride and by the phenomenon of tautomerism and desmotropism. A. H. N.

230. Waxes from Fatty Acids. German Conversion Process. Anon. *Chem. Tr. J.*, 18.8.39, **105**, 140.—The production of materials similar to wax or petroleum jelly by

heating distillation residues of fatty acids (*e.g.*, obtained from fatty oils, or oxidation of paraffin hydrocarbons) in the presence of catalysts, followed by reduction with hydrogen, is described by I.G. Farbenindustrie A.-G. in E.P. 506,678 of 1938. The catalyst used—*e.g.*, metallic iron or nickel or manganese oxide—splits off CO_2 at sufficiently high temperatures—*e.g.*, 200° C.—the carboxylic acids condensing to give ketones. Filtration or sedimentation removes the catalyst. Reduction with hydrogen converts carbonyl and carboxyl groups into hydroxyl and/or methylene or methyl groups, any double linkages being thus saturated. Hydrogenation is carried out in the presence of catalysts and preferably at 160–200 atmospheres pressure and 200–400° C. The resulting products are pale, frequently colourless, similar to wax or petroleum jelly, consisting mainly of high-molecular-weight alcohols and/or hydrocarbons. They are suitable as medicinal or veterinary salves, or for the protection of metals against industrial or other gases. A typical product from crude fatty acids obtained from Fischer–Tropsch paraffin wax was similar to petroleum jelly, and smeared well, exerting no irritant effect on the skin. It had an acid value of 0, saponification value 0, and melting point 61° C. C. L. G.

231. Synthetic Rubbers. A Review of their Compositions, Properties, and Uses. L. A. Wood. U.S. Nat. Bur. of Standards Circ. C. 427, 1940.—A detailed discussion, with bibliography, is presented of the methods of production, raw materials used, chemical reactions, general conditions of polymerization or condensation, and properties of twenty-nine commercial varieties of synthetic rubber. These are classified as: (1) chloroprene polymers (*e.g.*, Neoprene); (2) butadiene polymers and co-polymers (*e.g.*, Buna); (3) organic polysulphides (*e.g.*, Thiokol); (4) *iso*butene polymers (*e.g.*, Vistanex); (5) plasticized vinyl chloride polymers (*e.g.*, Koroseal), and (6) methyl rubber. General applications, their comparison with natural rubber, quantities produced, and cost of production of some of the more important types are outlined. C. L. G.

232. Patents on Special Products. Standard Oil Development Corp. E.P. 528,792, 7.11.40. Appl. 24.4.39. Preparation of improved viscous liquids for use in shock absorbers, dash-pots, vibration dampeners, etc. The composition has a petroleum-oil base which blends with a minor proportion of a viscosity building oil to form a hydraulic medium.

E.I. Du Pont de Nemours. E.P. 529,311, 19.11.40. Appl. 15.5.39. Apparatus for the recovery by solvent extraction of extractable materials, particularly oils, fats, and waxes, from solid materials containing these substances. The apparatus comprises a long extractor tube inclined to the horizontal and connected at its lower end with the lower part of a short riser tube, means for delivering solvent to the upper part of the short tube, means for discharging lixivium from the upper part of the long tube, and means for moving solid material downwards through the long tube and upwards through the short tube.

Compagnie Française de Raffinage. E.P. 529,429, 20.11.40. Appl. 31.5.39. Preparation of active wave-stilling oils by partly saponifying a natural glyceride oil having an iodine number not less than 120, to produce a mixture of the fatty acids thereof with unchanged oil in which the fatty acids constitute between 30% and 70% by weight of the mixture.

W. G. Horsch. U.S.P. 2,221,380, 12.11.40. Appl. 25.1.38. Preparation of an oil composition for use in turbines, transformers, etc., which is capable of cleaning and maintaining clean the passages of such equipment. The composition consists of a homogeneous mixture of a mineral oil and a compound selected from the group acetophenone and benzophenone. H. B. M.

Detonation and Engines.

233.* Factors Involved in Lead Susceptibility. A. W. Trusty. *Refiner*, April 1940, **19** (4), 93–96.—The detonation theory, the spontaneous theory, and the peroxide theory of knocking are explained. The rate of rise of pressure cannot be the sole

factor determining the tendency of a fuel to knock. The rate of pressure rise (1) increases with the molecular weight of the normal paraffin hydrocarbons; (2) varies inversely with the number of methyl groups attached to an aromatic nucleus; (3) is approximately the same for hydrocarbons of widely varying anti-knock properties, for example, benzene and *n*-octane, toluene and *n*-heptane, xylene and *n*-hexane; (4) about the same for the higher alcohols (high anti-knock compounds) as for the corresponding paraffin hydrocarbons (low anti-knock compounds); and (5) is very rapid for ethyl ether.

The lead susceptibilities of pure hydrocarbons are found to be: (1) the lower-boiling paraffins and naphthene, or those hydrocarbons with the highest anti-knock values are most susceptible. There is a marked difference between the light and heavy hydrocarbons. (2) The aromatics are fairly susceptible to tetraethyl lead. Aromatics with a saturated side-chain are more reactive to lead than when the saturated side-chain is replaced with an unsaturated side-chain. (3) The unsaturated hydrocarbons, on the other hand, show much less variation in lead susceptibility, regardless of their original octane number.

As the double bond progressively moves towards the centre of the molecule, the effectiveness of lead in the compound increases. With a number of unsaturated hydrocarbons, lead has a "negative" effect—that is, the octane number is actually lowered by the addition of tetraethyl lead.

Acid treatment of cracked gasolines removes sulphur compounds and certain of the unsaturated hydrocarbon constituents. The removal of the unsaturates results, in general, in a lowering of the octane number, but by the removal of these same hydrocarbons, the lead susceptibility is raised.

Natural gasoline has in general the highest susceptibility to tetraethyl lead of all commercial blending stocks.

Low-sulphur, paraffin base, straight-run gasolines have the next highest effectiveness to the addition of lead.

High-sulphur, naphthene base, straight-run gasolines are considerably less reactive to lead blending than the low-sulphur, paraffin-base gasolines.

Cracked gasolines have lower lead susceptibilities than straight-run products—the degree depending on the sulphur content and the extent of cracking to which the stock was subjected. A. H. N.

234.* Octane Number. W. W. Scheumann. *Refiner*, April 1940, **19** (4), 102.—The paper is non-technical in treatment, giving a review of the concept and determination of octane numbers, the limitations of the method, and a general as well as specific warning against its misuse.

The discussion further points out that the octane number in any of its modifications is not a true measure of intrinsic anti-knock quality of fuels. It can never truly correlate with all types of car performance on the road, because such performance depends on engine characteristics and type of operations as much as on fuel characteristics. The oil companies have, therefore, greatly over-emphasized the value of the octane number, and have misused it in many ways.

Anti-knock quality in motor fuel is of definite economic value to the consumer. However, present engines do not use this quality most effectively, and research indicates that engines could be improved in this respect. In the past such improvements were not always made, because the refiner lavishly supplied additional anti-knock quality in his fuel to make up for such shortcomings. Only time will tell how much longer he can continue this practice. A. H. N.

235.* Knocking Octanes. C. H. Van Hartesveldt and H. W. Field. *Refiner*, June 1940, **19** (6), 209–214. *Paper Presented before American Petroleum Institute.*—In this paper a comparison is presented of the value of improved automobile performance as observed by the "average driver," with the incremental costs of producing gasolines of successively higher octane numbers.

The automobile-performance observations have been made in car models now being operated by the public, rather than in engines specifically designed for extremely high octane gasolines.

Further, it is notable, in view of many recent controversies, that "road octanes"

are used throughout the discussion, even though it is admitted that the road-octane method leaves something to be desired in the way of reproducibility from car to car.

The improvement in the performance of present-day motor-cars, as a result of wide-range increases in gasoline octane numbers, is shown to be minor relative to the increase in refinery cost of effecting these octane increases as reflected in potential reduction of the profit returns on investments in the petroleum industry.

A note of caution is struck, lest refiners let competitive enthusiasm undermine the financial stability of the industry instead of proceeding on a sane and logical course of developments for the future. A. H. N.

236.* **Behaviour of Gasoline-Coal Fuel in Spark-Ignition Engines.** J. E. Hedrick. *Refiner*, August 1940, **19** (8), 285–286.—Data are presented on engine performance where a gasoline–coal suspension was used, and the results are compared with those obtained when the same gasoline was used alone. The gasoline had a specific gravity of 0·7234 at 60° F. and the mixture had 0·7332 specific gravity at 60° F., containing 2% by weight of coal of a particle size ranging from 1 to 74 microns. The engine had four cylinders and its speed was rated at 1200 r.p.m. Other data are included.

Although no appreciable detonation developed with gasoline even at maximum load, the use of the mixture gave a prominent detonation at the same load. The engine developed less power, due probably to detonation, when coal suspension was used. Further, on a constant load test, the engine was unsteady, alternately developing severe knock and then running smoothly for a while. The exhaust was clean, and no smoke developed with the use of coal, but the tests were too short to enable a study to be made on the effects on the cylinders. Coke in loose flakes was deposited on the entire combustion chamber. The lubricating oil suffered badly, and tar was formed on the valve stems and drained into the crankcase. A. H. N.

237.* **Mileage Marathon Develops Interesting Data.** R. J. Greenshields and L. E. Hebl. *Oil Gas J.*, 1.8.40, **39** (12), 33.—Useful engineering data, mainly on methods of increasing mileage, have been obtained as a result of a mileage contest on a definite quantity of fuel. Lighter cars are handicapped on a theoretical basis, using data on published friction values based on actual road measurements, on wind resistance, mechanical efficiency, and a number of other assumptions. Methods of increasing mileage included: adjustment of spark timing and carburettors, inflating tyres to 50 lb. per sq. in., adjusting wheel alignment, use of exhaust heated differential housing and insulated crankcase and transmission (based on article by Hebl & Rendel, *N.P.N.* 24.7.35, p. 36), shielding radiators to give maximum engine temperatures and disconnecting fans, water-pumps, and generators. A new driving technique was also successfully used, in which the engine was accelerated at full throttle from 16 to 37 m.p.h., and then was coasted to 16 m.p.h. with the ignition off. C. L. G.

238.* **Clement–Pigneguy Knock Indicator.** D. M. Clement and P. G. Pigneguy. *J. Inst. Petrol.*, November 1940, **26** (205), 489–514.—An indicator is described which is unaffected by combustion pressure, and which allows testing to be carried out over the entire octane scale without alteration of the original setting. A. H. N.

239. **Patent on Detonation and Engines.** F. M. Pyzel. U.S.P. 2,218,137, 15.10.40. Appl. 2.8.37. Subjecting a gasoline-type motor fuel containing 5–60% methyl *iso*butyl carbinol to combustion in a spark ignition engine as an anti-knock fuel. H. B. M.

Economics and Statistics.

240. **Market for Liquefied Petroleum Gases Expands a Third in 1939.** R. R. Sayers. *U.S. Dept. of the Interior, Bur. Mines, Mineral Market Reports*, M.M.S. 842.—Figures given in this report indicate a definite increase in sales of liquefied petroleum gases during 1939 as compared with 1938. With the exception of chemical manufacturing, the increase is reflected in all important uses of these gases. Sales of "bottled gas" employed largely in kitchen equipment in rural districts situated beyond the city

gas mains rose by more than 50% in 1939. Gas companies using liquefied petroleum gases for enriching manufactured gas or for direct distribution increased their purchases by nearly 37% during the year. Also industrial demand which had shown a decline in 1938 as compared with 1937 had an outstanding increase of 59% in 1939.

During 1938 deliveries of liquefied petroleum gases were divided in approximately equal proportions between propane, butane, and propane–butane mixtures. During 1939, however, owing to the increase in demand for "bottled gas" consisting predominantly of propane, the proportion of sales accredited to propane increased from 33 to approximately 36%, and a corresponding drop was recorded in propane–butane mixtures.

H. B. M.

BOOK REVIEW.

Sedimentary Petrography. By H. B. Milner. Pp. xxiii + 666. Thomas Murby & Co., London. 1940. Price 45*s*.

A new edition of this well-known work has been long overdue, and will be welcomed by all who knew, and had profited by, the second edition which was published in 1929. In his preface to this third edition, the author points out that unavoidable delay in producing it is offset by the opportunity afforded to review over a decade of international reactions to the subject, and to take care of the many activities, both in research and in its economic applications, which have marked its progress in the interim. It is in its application for the solution of many economic and industrial problems that Sedimentary Petrography may claim to be a comparatively new science, and it is very evident that remarkable advances have been made during the last ten years in the scope of such applications. This is well brought out by a comparison between the old and new editions, for whereas the former stressed more particularly the application of systematic petrography for the correlation of strata and subsurface geology, with an additional chapter on the study of soils, the latter embraces such subjects as: the asphalt industry (building construction), the technology of building, cement, ceramics, glass, highway construction, refractories, water supplies, and even criminology and industrial maladies.

Although the general arrangement of the subject-matter is not very different from that of the 1929 edition, many of the chapters have been expanded and embellished by new illustrations or diagrams, new chapters have been added, and in some cases the old phraseology altered and improved.

It would be impossible, within the scope of a brief review, to comment in detail on the many changes which have been effected, but for the sake of those already in possession of the old edition and who might wish to know whether the acquisition of the new volume was worth their while, some of the outstanding examples of new and valuable subject-matter may be referred to.

The chapter on "Sampling, Storage, and Records" has a new section on sampling from bulk for laboratory analysis, and the author goes to some length in stressing the necessity for guarding core samples from being interfered with by unauthorized persons.

Laboratory technique receives considerably more attention, and now occupies three chapters instead of one. There is a new section devoted to mounts of thin sections in media other than Canada balsam. The second edition made but a brief reference to the application of synthetic resins for this purpose, and the new volume deals with the subject in considerable detail, even to the extent of describing the method and apparatus required for preparing such resins in the laboratory. At first sight this might appear to be outside the legitimate scope of a book about petrography, and the more so because such resins are obtainable commercially ready made.

There are occasions, however, when the freshly made material is more convenient to use, especially for thorough impregnation, and for this reason a description of the method for preparing it is fully justified.

In the list of essential equipment for the treatment of incoherent rocks for the recovery of heavy minerals there is a change in the recommendations, in that sieves for special quantitative work are now referred to B.S.I. standards instead of those of the I.M.M.

Sieve analysis, which was only briefly referred to in the second edition, now receives considerable attention, about eight pages being devoted to the subject, and there is included a useful table giving the comparative apertures of the I.M.M., Tyler, A.S.T.M., and B.S. series of sieves, as well as some valuable hints on technique and the expression of results.

Elutriation is also dealt with more extensively than in the previous edition, a valuable contribution being the author's experience in the method of using Andrew's Kinetic Elutriator. There are also new paragraphs on air elutriation and centrifugal methods of separation.

A description of the Hallimond Electro-Magnetic Separator is another interesting addition. Although an excellent photograph of this apparatus is reproduced, the description would have been better illustrated by a line diagram, since the photograph fails to show some of the essential features. For instance, the position of the first and second separating magnets is hidden from view.

There is a new chapter which deals somewhat briefly with the application of *X*-rays, spectrum, fluorescence and micro-chemical methods of analysis. Within the scope of the nineteen pages devoted to these subjects, each of which might claim a volume to itself, nothing more could be expected than a bare outline of the special applications which such methods might have to sedimentary petrography. Actually the chapter falls short of expectations in this respect, since space has been used for generalized descriptions of apparatus and methods proper to these dissimilar sciences which might perhaps have been more usefully employed in specifying their special application to the true subject-matter of the book. Nevertheless, as the author himself points out in a concluding paragraph, those interested in the subject may obtain further details from the special publications which he cites in footnotes to the chapter.

The chapter on the "Microscopical Examination of Sediments" has been considerably extended and brought up to date. The old diagrams illustrating pleochroism, extinction, refractive index, and interference phenomena have been replaced by new and considerably improved illustrations. That the book is abreast of the time is evidenced by the use of "black-out" as a synonym for extinction, although the analogy would be somewhat strained if one spoke of parallel, oblique, or incline black-outs.

The chapter entitled "Quantitative Data" in the old edition is replaced by one called "Methods of Testing," which comprises a fair selection of standard methods taken from the publications of I.P.T., B.S.S., A.S.T.M., and other authoritative sources.

A characteristic and valuable feature of the old edition was the chapter on "Diagnostic Properties of Sedimentary Rock Minerals." This included the complete description of 72 minerals, 55 of which were illustrated, and brief descriptive notes on 25 others which were referred to as essentially sporadic and local minerals.

The new edition describes 131 minerals with illustrations of 61, the 25 sporadic examples being now included in the general category, with somewhat fuller descriptive details than heretofore.

The introductory pages of this chapter now contain illustrations of typical forms in the various crystallographic systems, and a complete list of all the minerals dealt with arranged according to their crystallization systems.

The chapters on "The Petrography of Consolidated Sediments," "The Principles of Correlation," and "Palæogeographical Problems" are not greatly different from the corresponding chapters in the older edition, although the tables of tendencies as regards occurrence, stability, and frequency, and the geochemical notes on the latter subject, have been considerably enlarged.

The second edition contained an appendix consisting of a set of tables in which some of the commoner detrital minerals were classified according to colour, refractive index, and behaviour with polarized light. This has been omitted in the new edition, and in its place are substituted a series of eight appendices, each representing a separate table listing essential properties such as system of crystallization, specific gravity, hardness, refractive index, etc., arranged in order of increasing numerical values.

This is a noteworthy improvement on the older arrangement as an aid to mineral diagnosis, and should prove of great value to students, both for ready reference and as a means of impressing the characteristic properties of the minerals on their memories.

The volume is completed by an extensive bibliography, both for the general subject and separately for some of the individual chapters, it is well and adequately indexed, and both the printing and binding are excellent.

In conclusion, it should be evident from the above that owners of the old edition of this work would be well advised to obtain possession of the latest edition if they wish to be up to date in their knowledge of the subject, whilst to those who approach the subject for the first time the book can be heartily recommended as one of the best at present available.

J. McConnell Sanders.

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Geology and Development.

241.* New Method of Constructing Subsurface Models. K. M. Bravinder, D. H. Sheldon, and J. E. Koogle. *Petrol. Tech.*, Jan. 1941, A.I.M.M.E. Tech. Pub. No. 1271, 1–4.—As a substitute for peg models or glass panel models, celluloid sheets arranged vertically and in a series at right angles to the structural trend are used. Well columns are traced in India ink on one side, and the structural correlations are traced on the other side. The celluloid sheets are suspended in a suitable frame at the correct spacing. The vertical and horizontal scales should be equal.

A model with ten sheets of 60-gauge non-inflammable celluloid 20 by 48 in., with the base and fittings, cost $60, and to fill in sixty-one wells on a scale of 1 in. to 200 ft. required 2 weeks' plotting by two men.

These models are very useful where complex structures occur, and are a useful complement to the sections and contour maps. G. D. H.

242.* Vigorous Search for Reserves Successful in U.S.S.R. M. Joel. *Oil Gas J.*, 26.12.40, **39** (33), 115.—During 1940 490 geological, geophysical, and test drilling parties were operating in the U.S.S.R., and primary exploration was completed in twenty new areas. The Grozny area is declining from its 1932 peak, whilst the Ural–Volga region is rising in importance. The principal source of new production in Azerbaijan is the sub-Kirmak series. Production has extended under the sea off the Apsheron peninsula. Still deeper production has been found at Kala, and an entirely new region has been opened at Siazan, in north-east Azerbaijan.

The deep production at Old Grozny will probably be more effectively developed by the new directional drilling technique which has been introduced. A new pool has been opened at Oisungur, 60 km. east of Grozny, at a depth of 1460 m.

Further discoveries have been made in the Penza and Ivanovo districts of the Ural–Volga region. At Buguruslan good production has been found at a depth of 250–300 m. A 1937 discovery at Tuimazy, 150 km. north-west of Sterlitamak, has now been enlarged considerably. Several oil-saturated limestones of Devonian age have been found. The Romny discoveries of the Ukraine have been followed up and others made at Dmitrovka. Oil is said to have been found at Lubna in the Poltava district. Numerous abandoned and shut-in wells have been restarted in former Poland.

The indications are said to favour full-scale testing at Tavdinsk (West Siberia), Tolbinsk (Yakutia), the Ayano-Maisky district near the sea of Okhotsk, and several areas in the vicinity of Leningrad and Moscow.

Proved gas reserves amount to 50 billion cu. m. and estimated reserves to 700–900 billion cu. m. New gas-fields ready for exploitation exist in Daghestan, West Ukraine, Izhma (near Ukhta), and at various points in the Ural–Volga region.

Much oil has been obtained by the rehabilitation of shut-down wells in the Caucasian region.

The Estonian oil-shale reserves amount to 5,000,000,000 metric tons, and contain up to 43% of combustible matter. Koksher Is., near Tallin, has an important gas reserve, and Esel Is. possesses oil indications.

Various new drilling devices are noted; there is an electrical oil-field model and a rapid porosity measurer on the Wheatstone-bridge principle, and thermal logging has been applied to cased holes. G. D. H.

243.* Hawkins, East Texas, Discovery Starts Drilling Campaign. R. M. Sanford. *Oil Gas J.*, 9.1.41, **39** (35), 8.—A month ago a well 3-ml. north of Hawkins, south-west Wood county, indicated oil production in the Woodbine sand, but during testing salt water came in and it is giving 80% water and 144 brl. of oil/day. On 30th December two other wells blew in, one estimated at 2000 brl./day, the other as a wild gasser. These are 200–400 ft. higher structurally than the discovery well.

In Rotondi 1 Cobb the shut-in tubing pressure was 710 lb./in.^{2} The Nacatoch sand was topped at 2245 ft., Pecan Gap at 2954 ft., Austin Chalk at 4075 ft., Woodbine at 4398 ft., and oil sand at 4450 ft. The gasser was estimated to flowing 50,000,000 cu. ft. of gas/day, and was brought under control at 25,000,000 cu. ft./day. The gas well produces from the sub-Clarksville sand of the Eagle Ford.

Probably the Hawkins area has a large anticline, and it is believed to be due to a deep-seated salt dome. Leasing is very active, several wells are starting, and locations are being sought for thirty to thirty-five wells. G. D. H.

244.* Ten Pay Levels Now Producing at Texas' Hull-Silk Field. R. M. Sanford. *Oil Gas J.*, 9.1.41, **39** (35), 13.—The tenth pay level at Hull-Silk is at 4563 ft., and is prolific. The field's discovery well found oil in the Strawn at 3800 ft., and since then oil has also been found at 464 ft., 962 ft., 1403 ft., 1627 ft., 4000 ft., 4300 ft., 4700 ft., 5200 ft., and 4563 ft. The well in the new horizon is gauged at 1246 brl./day.

Hull-Silk is on a north-east–south-west-plunging anticline, with several hundred feet of closure in the lower strata. The majority of the pay levels, except those at 3800 ft. and 4300 ft., are of the lenticular sand type or modified stratigraphic traps. They are distributed throughout four series of Pennsylvanian age. At the surface are Permian beds. The shallowest sand is in the Upper Cisco, and the other shallow pays are in the Lower Cisco and Canyon. The 3800-ft. and 4300-ft. sands are in the Strawn. The deepest zones are in the Caddo lime of the Bend series.

The Ordovician has not been tested, but the Simpson or Ellenburger may yield oil as at K.M.A. The Mississippian lime may be productive, for Mississippian beds have been found, in contrast with their general absence in much of the surrounding region.

Hull-Silk has 500 wells and a daily allowable of more than 10,000 brl. In no case does more than one horizon give oil in a single well, because of the expense of setting separate casings for each producing sand. The deep zones are by no means fully defined, and extension is going on steadily. 12,000 acres of production have now been proved. Some of the shallow sands cover only a few hundred acres, whilst the 3800-ft. and 4300-ft. sands cover the whole field. New shallow sands are found in extending deep production. There is little or no gas cap above any of the pay levels. In the 4300-ft. horizon the bottom-hole pressure is 1500 lb./in.^{2}

A short description is given of the drilling equipment and technique. A gas-recycling project is being organized. G. D. H.

245.* Well Logs and Field Data of Active Oil Areas—Central San Joaquin Valley. Anon. *Oil Gas J.*, 9.1.41, **39** (35), 50.—Oil has been produced in the San Joaquin Valley since about 1896, and production has now been obtained below 13,000 ft. The fields of the western part are in the foothill belt of the Coastal Ranges. The older Coalinga fields have given more than 350,000,000 brl. of oil, and these prolific fields led to prospecting farther out in the basin, resulting in the discovery of a number of curved trends. The earlier discovered fields on these trends produced from the Etchegoin (Pliocene). In 1932 the Temblor (Miocene) was proved productive on the Kettleman North Dome, and later the Avenal (Eocene) was opened up.

The San Joaquin Valley is a foredeep in front of the Coast Ranges which in the Tertiary was filled with sediments from the Coast Range and from high land to the east. The beds pass upwards from dominantly marine through partly marine and continental to wholly continental. Elongated anticlines were formed near the margins, but farther out in the valley the structures are smaller and less regular. There are many unconformities, and the shore-line deposits round the uplifts form excellent sites for oil accumulation.

New producing horizons are likely to be picked up on structures which have not proved productive either towards the margin or deeper in the basin. The estimated ultimate recoveries range from 11,000 to 56,000 brl./acre.

A map and a series of columnar sections are included. G. D. H.

246.* Lisbon Sugar Creek Shows Interesting Possibilities. F. H. Miller and G. Weber. *Oil Gas J.*, 16.1.41, **39** (36), 23.—The Lisbon field was discovered in 1936, and gives oil from the Pettit lime of the Lower Glen Rose. It covers 6500 acres. In 1939 a deep test was taken to 6900 ft., and encountered three Cotton Valley sands showing gas-condensate production. It gives 110 brl. of condensate/day with 7,000,000 cu. ft. of gas, which is used for repressuring the Pettit lime horizon. The structure appears to be a large anticline with the field on the south flank. The Pettit production is

largely controlled by porosity. The Lower Glen Rose and deeper beds have been little explored except on the south flank.

The Sugar Creek structure is a dome separated from the Lisbon structure by a shallow syncline. Oil and gas production are developed in the Lower Glen Rose, and large sand bodies show oil and gas in the Cotton Valley formation, although they do not at present produce. One recent deep test was disappointing, but a second was more successful. Oil saturation was found in the transitional zone above the Hosston at 5341–5362 ft., and this zone gave 75 brl. of oil/day in a well which was deepened to it.

The Vaughn sand of the Cotton Valley formation gives gas and condensate. This sand thickens down dip to the south-west, and the Cotton Valley sands improve in productivity down-dip.

The deep Cotton Valley sands in the Sugar Creek test were thick, but the porosity and permeability were too low for commercial production.

A subsurface structure map and cross-sections are included. G. D. H.

247.* U.S.S.R.—Development of Gas Reserves Planned by Soviet Industry. Anon. *Oil Gas J.*, 2.1.41, **39** (34), 27.—The gas reserves of Russia are estimated roughly at 700–900 billion cu. m., but reserves ready for commercial exploitation are only 50,000,000,000 cu. m., located mainly in the oil-fields. 2,900,000,000 cu. m. were recovered from the oil-fields in 1939, but even where recovered systematically it was used wastefully. Recent regulations require better utilization of the gas.

The first gas areas which will be ready for development are those of Daghestan, West Ukraine, Izhma in the Komi Republic, and a gas- and oil-field in the Buguruslan district. In Western Ukraine gas-wells are at present yielding 200,000,000 cu. m. of gas/year. The Izhma gas-wells are believed to be very prolific.

G. D. H.

248.* Australia—Secondary Recovery Considered for the Lakes Entrance Oil-field. Anon. *Oil Gas J.*, 16.1.41, **39** (36), 35.—Thirty-eight wells have been drilled at Lakes Entrance which show production over an area of 5 sq. ml. The 33-ft. producing sand is 1200–1400 ft. deep and slightly terraced. Its porosity is 15%, and oil saturation 27%. The average permeability is 77·5 millidarcys. Much water has invaded the field, and the oil is produced as an emulsion with 97% of water. Various methods of secondary recovery are being considered. G. D. H.

249.* Improved Wildcatting Results Expected in Mississippi in 1941. G. Weber. *Oil Gas J.*, 23.1.41, **39** (37), 16.—Despite the greatest search for oil in Mississippi in 1940 the results were disappointing, for only a minor field was discovered. The discovery of commercial oil in 1939 led to extensive leasing and wildcatting, often with little geological preparation. Ninety-five wildcats were drilled, many of them being far from satisfactory tests. Inadequate geophysical work was undertaken, and many so-called "highs" proved normal or low. More geological data seemed necessary to aid in geophysical interpretation. However, recently exploration has improved in quality.

The greatest activity was in central and west central Mississippi, where the Cretaceous Selma chalk, Eutaw and Tuscaloosa, productive at Tinsley and Pickens, were the principal wildcat objectives.

The coastal section may produce from the Sparta-Wilcox, and involves deeper drilling. In the north-east the Hartselle and Bethel sands and the Gasper lime of the Palæozoic are asphalt-bearing at outcrop and may yield oil on suitable structures down-dip.

Tinsley's curtailed production is 13,837 brl./day from 109 wells. The most extensive sand, the Woodruff ranges 0–100 ft. in thickness, thickening down-dip. The Stevens, Perry, Lammons, and Powell sands may also yield oil in Woodruff wells. Tinsley's oil reserve is conservatively estimated at 37,000,000 brl., over an area of 4500 acres. The limits are only defined in the east. Most of the wells are on the pump.

Pickens has only slight closure. Production is in the Wilburn sand of the Eutaw. The four wells have produced 290,000 brl. of oil. G. D. H.

250.* Paraguay–Uraguay—Exploration Fails to Reveal Oil Indications. Anon. *Oil Gas J.*, 23.1.41, **39** (37), 25.—Geological investigations in various parts of Uruguay have failed to reveal any substantial oil indications. The only boring which traversed the whole of the Gondwana beds is at Yaquare.

A 5000-brl. refinery has been completed at La Teja.

No exploratory drilling has been done in Paraguay, and there is no specific information as to the presence of oil-bearing formations. In eastern Paraguay the Palæozoic formations in which oil may occur are prominent in the valley of Piribebuy. At Villa Hayes are beds like those found deep at Salta in Argentina. G. D. H.

251.* Anse La Butte Salt Dome Shows Brisk Development. N. Williams. *Oil Gas J.*, 23.1.41, **39** (37), 14.—For many years only small wells were found in shallow sands over the Anse La Butte dome, but recently prolific flank sands have been developed. A year ago the production was less than 80 brl./day, but now the allowable is more than 2521 brl./day.

On virtually all the fifty-five domes of the Louisiana Gulf Coast drilling is being carried on, and at present only ten are without production, a number which will probably be reduced. The first drilling on Anse La Butte was in 1899. Up to 1907 several small shallow wells were brought in, and then a 3000-brl. well was drilled. Sporadic drilling over the dome continued to 1930, the best sands being found at 900–2000 ft. Flank production was then sought, and a sand at 3700 ft. came in for a short time. Several deep tests were drilled, in consequence of which deeper production was revealed. Now twenty-one flank sand wells have been completed, taking oil from six different sands in sectors south-west, south-south-east, and east of the dome. The Breaux sand was opened on the south-west at 4630–4650 ft. On the south is the First Moresi sand lying at 2439–2478 ft. The Patin sand on the south-east is the most prolific. In places it is 200–300 ft. thick, and lies at 4500–4800 ft. The Patrick sand was discovered on the eastern flank at 3637–3647 ft. South of the dome is the Second Moresi sand at 2848–2896 ft., and on the south-east is the Bergeron at 3240–3270 ft. The gravity of the oil produced varies with the sand. G. D. H.

252.* Paloma California's First Distillate Field. L. P. Stockman. *Oil Gas J.*, 23.1.41, **39** (37), 17.—The search for oil round the edge of the Paloma field has failed. Evidently the field is a typical distillate field. It has produced 150,000 brl. of oil of 52° A.P.I. Unit operation seems essential for satisfactory development. Its extent and productive limits remain undefined, but the area will probably be large. A minimum of 1200 acres seems likely. The latest well penetrated the pay at 10,275 ft. The structure is apparently anticlinal.

The transport of distillate production from Paloma may be a problem, for it is 500 ml. from the main refining centres. G. D. H.

253.* Well Logs and Field Data of Active Oil Areas—South-eastern Nebraska. Anon. *Oil Gas J.*, 23.1.41, **39** (37), 42.—Early development was in a belt in the south-eastern part of the State. An extension of this belt gave a series of shallow gas-fields. For many years the northern part of the Forest City basin to the north of this belt was not considered productive, but in 1939 production was found in this basin. Three pools in this area yield oil from the Hunton lime. Encouraging shows have been found in the Viola.

The Forest City basin is bounded on the west by the Nemaha granite ridge, on the south by the Ozark uplift, and on the north-east by an uplift in eastern Missouri. In the northern part of the basin the Dakota sandstone overlaps from the west. Movements of the three uplifts bounding the basin gave rise to a number of unconformities, wedge edges, and shoreline deposits in the Pennsylvanian, which form stratigraphic traps. Commercial production has been found in some of these Pennsylvanian sands in the south-west part of the basin, and in the Hunton lime on structures associated with faulting and warping on the east side of the Nemaha uplift.

Up to the present the Pennsylvanian has given much gas and relatively little oil. This is probably due to much haphazard drilling. Deeper formations will almost certainly be productive in this basin.

A stratigraphic column, a series of columnar sections, and a geological map are included. G. D. H.

254.* North Texas Area Expanding Rapidly. Anon. *Oil Wkly*, 30.12.40, **100** (4), 16.—Crude oil from the shallow areas is now of secondary importance, for the new deep fields developed in the past three years account for more than 50% of the North Texas allowable output. During the first ten months of 1940, 1796 wells were completed, as compared with 1714 in the same period of 1939. The average depth was 2647 ft. In the first ten months of 1940, 32,093,802 brl. of oil were produced, 24·9% more than for the corresponding period of 1939. Eleven new fields and nine new pays have been found and the average producing depth was 4498 ft.

Various data about reserves, drilling, etc., are tabulated year by year from 1935 onwards.

The history of the search for oil in North Texas, and in particular of the development of deep production, is described in fair detail. Shallow production was opened at Petrolia in 1905, and up to 1919 production did not generally go below 2000 ft. It was from the Cisco, Upper Canyon and Upper Strawn production was opened by 1923, and Ellenburger in 1926, but the latter was only shallow. Two deep tests were completed as Strawn and Canyon producers in 1930 in Wichita and Archer counties, but nearly seven years elapsed before the former strike gave appreciable returns. The Strawn boom at K.M.A. began in 1937. As regards productive area, this ranks amongst the five largest in Texas. The Strawn proved productive at Hull-Silk in 1938, and in 1939 Simpson production was found at a depth of 5350 ft. at Walnut Bend.

A table gives the North Texas deep horizon discovery data by formations, which range from the Cisco at 3200 ft. down to the Ellenburger at more than 6000 ft.

The Fort Worth syncline has now been shown capable of giving deep pools.

G. D. H.

255.* Stratigraphic Traps Source of Major Production over Central Kansas Uplift. J. A. Kornfeld. *Oil Wkly*, 13.1.41, **100** (6), 13–19; 20.1.41, **100** (7), 20–30.—In the past stratigraphic traps in West Kansas have been discovered accidentally rather than by specific exploration. Failures on top of a local structural anomaly do not condemn it until any possible flanking stratigraphic trap has been tested, *e.g.*, at Gorham the producing beds fringe the uplift and high wells are barren. The modern search for stratigraphic traps involves search for wedges inferred from past work along the strike; search for terraces flanking uplifts; search for truncated flank zones, and porosity changes.

As regards reservoir performance, stratigraphic traps have different characteristics from the usual domes and anticlines.

Flanking the Central Kansas Uplift are 110 local accumulations due to stratigraphic structure. At Wherry, one of the largest, an ultimate recovery of 36,622,000 brl. of oil is estimated for 7200 acres. A brief historical account is given of the development of the Kansas stratigraphic traps.

In pre-Cambrian times a series of parallel batholiths were intruded into schists and quartzites, and there was truncation giving clastics on the flanks of the uplift. The core remained land in Lower Cambrian times, but in Cambro–Ordovician times a series of sandstones transgressively overlapped the entire uplift. Thick dolomitic limestones followed, some of which covered the whole uplift, and there were strong unconformities at the top of the Arbuckle and sink-holes formed. The Simpson flanked the uplift except in the north-west. Then followed the Decorah shale, Simpson limestones, the Maquoketa shale (Lower Silurian), Mississippian beds and the Sooy conglomerate of Lower Pennsylvanian age, which rests on pre-Cambrian to Upper Bendian beds. The Central Kansas Uplift suffered Pennsylvanian movements and further movements in post-Cretaceous times.

Commercial oil accumulations occur in pre-Cambrian quartzites at several places on the Central Kansas Uplift. In most cases the Pennsylvanian covers the quartzite, and Ordovician and Cambrian lie on the flanks. All the accumulations lie on the crest of the uplift. Oil is found in the pre-Cambrian granite wash in the Hall pool. The "basal" Upper Cambrian sand yields oil and gas at widely scattered points, principally as local truncations off the flanks of the uplift. Stratigraphic traps in

the Arbuckle dolomite occur in a belt about 50 ml. long, most of the pools being on the south-west flank of the uplift. Variable lithology in the Simpson partly explains the conditions influencing stratigraphic traps in that formation. The Viola produces on a south-plunging terrace at Zenith and has alternate cavernous and hard impervious layers. Oil is obtained from the Hunton from a limited area where there are wedge-outs and local truncations. The Misener is productive, and a Mississippian chat wedge-out gives oil at Barnholdt. Commercial production of a wide range of oils has been obtained from the Sooy conglomerate, and oil is provided by the Marmaton lime series.

The various types of stratigraphic traps are classified, and there are lists of the number of pools, depths, and oil gravity for each producing formation, whilst a list of the pools is given with the producing horizons, discovery well data, number of wells, and oil gravity. There are maps of the pre-Cambrian structure, and isopachous contours on the Mississippian lime, Simpson, Kinderhook, and Misener.

Brief descriptions are given of some of the fields giving oil from each of the horizons described. G. D. H.

256.* War Intensifies Oil Search in Europe. Anon. *World Petrol.*, July 1940, **11** (7), 37–41.—In 1932 Germany's oil production was 237,000 tons, in 1939 647,000 tons. During the past three years 800,000–900,000 ft. were drilled annually. In 1939 two-thirds of the drilling was as extensions and exploration in new areas. The main new production in 1938–1939 was from Nienhagen and Reitbrook. The initial well at Reitbrook gave more than 1000 brl./day. Drilling in 1940 would probably be double that in 1938 and 1939. At St. Ulrich, Austria, a well came in at 500 brl./day. In addition to the fields of Austria and Czechoslovakia, Germany acquired Polish fields yielding about 1,000,000 brl. of oil/year, and which are probably capable of expansion. Germany's 1940 output will exceed 1,000,000 tons, for all wells are being pumped hard to get the maximum output.

The political situation in Rumania does not encourage drilling activity, and so in 1940 less footage will be drilled than in 1939.

Exploration in Italy has defined a petroliferous fold at Fontevivo, which has given several thousand tons of oil, and has opened important gas reservoirs in the Emilia region of the Apennine foothills. Deeper drilling is deemed necessary to reach oil horizons in the Po Valley. In the past five years Albanian production rose from 6000 tons in 1935 to more than 200,000 tons in 1939. In the Devoli fields there were 380 wells up to 1939 and they averaged 2000–2500 ft. in depth.

In Hungary some forty wells have been drilled, yielding about 5000 brl./day, and with new wells it is expected that production will be at the rate of 2,000,000 brl./year before the end of 1940. It is mainly from the Lispe area. There have been favourable shows around Lake Balaton. The wells range from a few hundred to more than 8000 ft. in depth, and average 5000 ft.

Concessions are said to have been granted in Yugoslavia, and geological investigation for oil has been undertaken in Bulgaria. In Greece, oil shows have been encountered in a well at 3000 ft. A well near St. Marcet, Herault, France, met a heavy flow of gas at 5000 ft., and a second well on the same structure, at Pinat, was at 6000 ft. in May, and was reported to have found oil of good quality. In April, a well at Torres Vedras, 30 ml. north of Lisbon, Portugal, had good oil showings at 2000 ft.

It is reported that during the last five years more than forty fields have been discovered and brought into production in the Ural–Volga, Middle Asia, and Far East regions of the U.S.S.R., together with new areas developed in the Baku and Grozny districts. Drilling is one of the weak points of the Soviet oil industry, and in recent years has been only, on the whole, 50–60% of that planned. G. D. H.

257.* Active Development of South American Deposits Despite Uncertain Outlook. Anon. *World Petrol.*, July 1940, **11** (7), 42–45.—The Tupungato field of Argentina has not yet been defined on any side but appears to be extensive. Wells indicate 800 ft. of sand at 6000 ft., and the production is of the order of 1000 brl./day. Wild-cats are to be drilled in the provinces of Salta, Jujuy, and Santa Cruz.

In western Venezuela the principal development work is being carried on in the Bachaquero field. The Oficina field of eastern Venezuela is now shipping 40,000

brl./day through the 100-ml. 16-in. pipe-line. The field is defined only on the north and north-east. The San Joaquin field is giving distillate. In Guario No. 1, two oil-shows were met in drilling to 8275 ft. The El Roble field lies north of the San Joaquin–Santa Rosa No. 2 trend, and has two wells giving light oil from almost 10,000 ft. El Machete No. 1 found small oil-shows. Wildcats are being drilled on the south-eastern edge of the Santa Ana field, on the edge of the Delta Amacuro, and at a point 63 km. south-east of Calabozo.

Regular drilling is proceeding on the La Cira structure of Colombia. Wildcatting is being carried on in the middle Magdalena valley. Monteoscuro Nos. 1 and 2 and Baull No. 1 failed to get commercial oil production, and two other wells were dry. Narino No. 3 was abandoned at 10,740 ft., having had oil-shows only. Two other wells in this section failed, but in the Las Monas section a well is pumping 18 brl./day. Drilling permits are being sought for the Chaparral area of the upper Magdalena Valley.

Two wells in Brazil are rumoured to have had initial productions in excess of 200 brl./day. In Peru a wildcat is being drilled in the north and another near the Chile-Bolivia–Peru border. A sizeable reservoir is indicated at Aguas Calientes, where two wells are producers, but oil disposal is a problem in that isolated field. Geological and geophysical work are being carried out on a 10,000,000-acre concession north of the Santa Elena field in Ecuador. G. D. H.

258.* World-wide Drilling Activities Continue in Unabated Volume. Anon. *World Petrol.*, July 1940, **11** (7), 58–63, 94.—In the world as a whole it seems that in 1940 drilling will be at about the 1939 level.

During the first quarter Canada produced 18,527 brl. of oil/day, against 13,585 brl./day in the corresponding period of 1939. At Turner Valley production has been established between the north and south pools. Tests are to be drilled 10 ml. north of Turner Valley, and to test the Devonian at Prairie Creek 75 ml. north of Innisfail. A well at Steveville, British Columbia, blew out with a gas-flow estimated at 65,000,000 cu. ft./day.

In Alaska a well was abandoned at Salmon Creek, and one on the Iniskin–Chinitna peninsula is suspended at 8775 ft. It logged oil- and gas-showings from 5000 ft. downwards.

Following an aerial survey, a geophysical survey has been carried out in Guatemala.

Promising structures have been located in Cuba, and almost all the test wells have had oil-showings, but no large producer has been brought in. Small shallow producers have been obtained. A well near Remedios in Santa Clara province found oil-showings at 2300 ft. At Recreo, Matanzas, a well drilled to 4104 ft. made good showings of oil from 900 ft. downwards, but lack of porosity and permeability in the lower beds caused the well to be abandoned. In Havana province, a well drilled to 5200 ft. had oil-showings, and the same was true of a well which went to 10,034 ft. The field in the Motembo district gives almost pure gasoline from shallow wells.

Oil-seepages occur in San Domingo. Five basins with well-closed anticlines are known, and test-wells have been drilled in two of these. Moleno No. 1 found shallow production (600 brl./day) between 400 and 600 ft. Wells on the Quita Corozo and El Magote structures went to 3200 ft. and 7505 ft., respectively, without oil-showings. A photographic survey has been carried out in Haiti.

Following the success of the Dharan field of Saudi Arabia, investigation has pointed to the existence of favourable structures elsewhere in that country. Production at Dharan (on the Dammam dome) was first obtained at 2175 ft. Later the more prolific Arab zone was found at 4200 ft. During 1939 the output was slightly less than 4,000,000 brl. of oil. Last April a well was brought in on the Abu Hadriya structure at a depth of 10,220 ft.

Bahrein's production is being maintained at about 20,000 brl./day. Crestal gas injection has been highly successful in this field. In 1938 a producer was brought in in Kuwait, and five wells have now been completed.

Geological and geophysical work have been executed in southern Iraq, and tests have been drilled in Syria. In April a producer was completed at Besiri, east of Dyarbakir, in Turkey. Wells have been deepened at Masjid-i-Sulaiman and Haft Kel, Iran, to the Eocene which is productive. Gach Saran is apparently a large structure.

Extensive geophysical surveys have been made in Sind and Baluchistan, India. Preliminary drilling is being carried out in New Guinea. G. D. H.

259.* Active Development in South America Likely on Conclusion of European Conflict. E. Ospina-Racines. *World Petrol.*, Sept. 1940, **11** (9), 52.—Intense development of the oil resources of South America followed the 1918 armistice, leading to a five-fold increase in production within twenty years. Economic, geological, technical, legal, and capital provision factors affect the problem of oil development, and the case of the Barco concession of Colombia is discussed with regard to these factors. All the factors were not favourable until 1936. The first productive well was completed in 1934, and by 1936 commercial potentialities had been revealed.

In five of the nine oil countries in Central and South America all the five factors are reported to be favourable, and in the rest it is believed that when favourable legal conditions are provided there will be further interest in the oil possibilities of those countries. G. D. H.

260.* High Officials Review Brazil's Drilling Progress. Anon. *World Petrol.*, Dec. 1940, **11** (13), 23–25.—In less than a year 29,234 ft. have been drilled in search of oil in Brazil, 20,444 ft. (six wells completed) in Bahia, 8757 ft. (one well completed) in Alagoas. Geophysical work has been carried out over an area of 112 sq. ml. Two wells in the Candeias district together give 69 brl./day of paraffin base oil. A well at Massaranduba was dry, and so was one at Salvador. Six wells in a line at Lobato include the two producers at 1287 ft. and at 1574–1672 ft. The latter has a shallow petroliferous horizon at 1244–1258 ft.

At Ponte Verde, east of Maceio, Alagoas, a well was completed at 7033 ft., and showed oil-saturated horizons at 4500 ft. (estimated to be capable of giving 15 brl. of oil/day and 253 cu. m. of gas). G. D. H.

Geophysics and Geochemistry.

262.* Gravimeter in World-wide Exploration. L. M. Mott-Smith. *World Petrol.*, July 1940, **11** (7), 64–67.—For all practical purposes the gravimeter has replaced the torsion balance, and to a considerable extent the seismograph for rapid reconnaissance. Although the instrument may fail to reveal some minor structures, it allows the majority of structures to be located in much less time and at a lower cost than is required to cover a region by other methods.

Test well-locations can be made on careful gravimeter work with stations 1000 ft. apart, as compared with 5000 ft. for reconnaissance. Buried granite ridges as found associated with oil in Egypt are readily discovered by the gravimeter.

Under average conditions 1500 stations/month can be observed with the new instruments. Instruments now in use weigh 35–50 lb., against 70–150 lb. for older types. A gravimeter has been designed for use under water.

A typical gravimeter party consists of seven–eleven men, including two–four surveying crews. G. D. H.

263.* Geochemical Exploration Comes of Age. W. R. Ransome. *World Petrol.*, July 1940, **11** (7), 72–75.—The history of the development of geochemical prospecting is briefly outlined. Observation showed that oil-fields had some leakage which formed characteristic patterns at the surface. These patterns were revealed in the gaseous, liquid, and solid hydrocarbons in the soil, and also in various inorganic materials. It is believed that the gaseous part of an oil accumulation escapes to the surface slowly through microscopic openings, and in doing so polymerizes partly to solids and liquids, and also carries to the surface various soluble materials encountered in the formations through which the gas passes. The solid waxy hydrocarbons are no longer used in geochemical search for oil, for, being limited to the surface layer of soil (topmost fraction of an inch), they are readily disturbed and contaminated. The hydrocarbon gases are present in quantity at depths of 5–10 ft., as are the heavier hydrocarbons. These depths are below all ordinary surface effects. Since the heavier hydrocarbons are more abundant than the gaseous hydrocarbons, they are more reliable for analytical determinations.

The question of significant values is one of experience and statistical analysis. If, on plotting analysis values as abscissæ and the number of points having a particular value as ordinates, the resultant curve differs markedly from a normal probability curve, then there is good reason to consider the outstanding values as significant in magnitude. G. D. H.

264. Geophysics. E. A. Eckhardt. *Bull. Amer. Assoc. Petrol. Geol.*, Aug. 1940, **24** (8), 1377–1385.—Present-day geophysical equipment and techniques are well advanced, and further improvements may relate largely to convenience and cost of operation. Yet in the field of utilization there is room for substantial improvement. An example is given of how a structure can appear as a gravity maximum or minimum according to its depth of burial, and in a second case gravity "highs" merely indicate the positions of buried outcrops. The reworking of old gravity maps by geologists and geophysicists together may yield valuable results.

Reference is made to a series of simultaneous observations of the tidal variation of gravity and to the bearing of such observations on our knowledge of the general geology of the earth. G. D. H.

265. Discussion of Geochemical Exploration (Soil Analysis). E. E. Rosaire, E. McDermott, R. H. Fash, *et al.* *Bull. Amer. Assoc. Petrol. Geol.*, Aug. 1940, **24** (8), 1434–1463.—A wide range of questions concerning the validity of soil analysis in the search for oil, the analytical technique and the hypotheses underlying the interpretation of the observed results are dealt with. Mechanisms are suggested for some of the phenomena. Some of the observations in geochemical exploration are severely criticized. G. D. H.

266. Critical Survey of Recent Developments in Geochemical Prospecting. S. J. Pirson, *Bull. Amer. Assoc. Petrol. Geol.*, Aug. 1940, **24** (8), 1464–1474.—Investigation seems to show that particle size is second in importance to chemical nature in fixing the amount of gas adsorbed. Hence a simple correction for particle size is not very satisfactory. The removal of the soil gas and the subsequent measurement of the amount of a known gas adsorbed to provide a basis for comparison are extremely involved if carried out satisfactorily.

It appears that the hydrocarbons in the soil may persist even after the oil has moved on to another site of accumulation. Furthermore, the haloes give no idea of the depth of the parent deposit. Hence soil-sample analysis for hydrocarbons is of doubtful value in its present form.

Soil-air samples seem to have certain advantages over soil samples. The maximum of hydrocarbons in the soil air is over the oil deposit. The sampling is more difficult than the taking of soil samples, but the analytical results require no correction for the nature of the soil. The hydrocarbon concentrations persist only over active oil and gas accumulations with sufficient pressure to cause the necessary effusion. A formula is presented which permits the estimation of the depth of certain forms of oil and gas accumulation. However, representative soil-air samples may not be obtainable in water-logged soils, or where hard rocks outcrop. Sampling must be done at a reasonable depth to avoid the effects of soil breathing. No adsorption should be possible by any part of the sampling device, and only a small suction should be applied in sampling, otherwise adsorbed hydrocarbons may be removed from the soil particles. G. D. H.

267.* Radioactivity of Sedimentary Rocks and Associated Petroleum. K. G. Bell, C. Goodman, and W. L. Whitehead. *Bull. Assoc. Amer. Petrol. Geol.*, Sept. 1940, **24**, 1529–1547.—The radioactivity of sedimentary rock samples obtained from oil-well cuttings and cores and of the crude petroleum produced from some of the wells was determined in an attempt to fix the source of the radon in crude oils. The samples included shales, sandstones, and limestones, and ranged in age from Oligocene to Ordovician. Rocks of such age are old enough for radioactive equilibrium to have been established with uranium. The measurements indicated that radioactivity is very variable in sandstones, less so in limestones, and practically uniform in shales. Pure sandstones and limestones have a minimum radioactivity, and higher values

are due to impurities, shale particles, etc. The quantity of radon and of radium in the crude oils investigated is very variable. The average radon content is ten times the amount in equilibrium with the radium present, thus proving that the greater part is derived from external sources. The maximum radon content and the maximum radon–radium ratio are found in oil from the Oligocene Frio sandstone, which is high in radium, permeable, and capped by shale. A low radon content and low radon–radium ratio are found in oil from the Woodbine sandstone, which is pure and has a low radium content.

The effect of radioactivity on crude oil is discussed, and it is pointed out that cracking of the type which takes place would account for the hydrogen present in some natural gases. Determination of the hydrogen content of soil gases is suggested as a method of geochemical prospecting for oil. S. E. C.

Drilling.

268.* Shale Shaker and Desander (for Drilling-Muds). Anon. *Oil Wkly*, 23.12.40, **100** (3), 34.—A sand-removing device is described for use in rotary mud systems. The device requires no power and very little attention, and its action depends entirely on gravity and a quiescent section of a tank so that the sand particles can settle from the circulated drilling-mud.

The principal part of this separator is a large rectangular steel tank having a sharply sloping floor, adequately braced, and mounted on skids, with a superstructure where twin shale shakers are mounted. Detailed dimensions and other characteristics are given. The floor of the tank slopes from the front to the rear so that the precipitated sand will flow to the lower side, where it is dumped by opening a swinging door, and controlled manually.

As the capacity of the desanding tank is sufficient to cause the circulated mud to quiet down in flow, the result is that most of the sand in suspension is precipitated to the sloping floor. Whenever the accumulation reaches a certain amount it is readily removed.

The whole system is cut into two parallel sections by appropriate baffles and plates, so that one or the other, or both, sections may be controlled independently and readily. A. H. N.

269.* Separate Units Aid Wire Line Coring. Anon. *Oil Wkly*, 13.1.41, **100** (6), 20–21.—The paper consists of practical hints and instruction on the correct use of sand lines for coring. Wire lines used for sand-line coring on 10,000-ft. tests are rarely chosen less than 9/16, with 5/8 the most commonly used size, more 7/8 being employed than the size below 5/8. Construction of the line varies with individual preference.

Proper spooling, regard to fleet angle, and enclosing the line are all stressed. Since sand lines rarely wear out when used for wire-line coring, more attention to proper ventilating of the line, together with an adequate and frequent doping of the line with the proper type and grade of lubricant, will work to postpone the corrosion which embrittles the individual wires, causing breaks, and resulting in replacement long before the wearing surfaces of the outside wires have been reduced in area sufficiently to impair effective performance or lower safety factors under tension. A. H. N.

270.* Drilling Wells Horizontally. L. Ranney. *Oil Wkly*, 20.1.41, **100** (7), 12–14.—Oil wells are often drilled 5000 ft. deep to penetrate 50 ft. of productive sand, so 99% of such a well is a total loss, in so far as production is concerned. In water wells the percentage of useless hole is much smaller, because the wells are shallower, but, due to a short radius of influence, high velocities of inflow, encrustation, and sanding up, vertical water wells do not represent the ideal to be attained. Hence it is argued that horizontal wells will give greater percentage productive penetration and better results.

After an encouraging success with a well drilled horizontally, which yielded a daily rate greater than the combined rate of the fifty nearest wells drilled vertically, a concrete-lined shaft was sunk, 800 ft. back from the first well, and 200 ft. from

another outcrop. A working floor was built 8 ft. above the concrete bottom, and an enclosed tank was lowered into the sump; this tank to receive oil produced with the drill-water. An electrically operated, specially built diamond drilling-machine was placed on the floor in the centre of the work-chamber. The wells from the work-chamber at the bottom of the shaft were drilled in diametrically opposite pairs, the mouth of each well being 1 ft. above the bottom of the sand.

To the south the oil-sand was flat, so the holes in that direction were level; but to the north the bottom of the oil-sand was wavy, so the wells in that direction were turned up and down to follow the undulations of the formation by means of a special tool. A new type of surveying instrument was developed, integral with the core-barrel, which instrument automatically surveyed the hole with an accuracy of $\frac{1}{16}$ in./10 ft.

Horizontal drilling in coal-mines and for water are also discussed. A. H. N.

271.* Wire Ropes Need the Care of a Machine. Anon. *Oil Wkly*, 20.1.41, **100** (7), 16–19.—The paper consists of warnings against the misuse of wire ropes and of practical hints for the prolongation of the life of wire lines.

Some of these remarks are the following: Sheaves should be as large as possible. The bending stress in a wire rope is that stress which is produced when the rope is bent around a sheave or drum. Therefore, the larger the diameter of the sheave, the longer the rope will last. If the grooves or sheaves are worn, rough edges are likely to cut the rope wires. In all cases the sheaves should be smooth and of a slightly larger radius than the rope. Experience has proved that fatigue and wear increase with speed. Rope life will vary approximately inversely with the square of the speed. Economy will result from increasing the load, if kept within the safe limits, and diminishing the speed.

Continued tension and release from tension result in ultimate deterioration, due both to the molecular or grain structure within the steel and the gradual breaking down of the hemp centre as a result of the cutting of the fibres within the core. This latter condition is also caused by gradual elimination of lubrication, which maintains fibre pliability. Material disarrangement will not take place unless the rope is loaded to a point equal to or larger than the fatigue limit of the material within the steel wires, which is about two-thirds its elastic limit, or roughly 44% of its ultimate strength. When loaded below the elastic limit, no permanent injury will result; when loaded above the elastic limit, the wires will stretch permanently. Between the range of overloading and underloading lies a condition of economical loading. Economical loading ranges have been established in the form of safety-factor values. A. H. N.

272.* Progress in Drilling. Anon. *Oil Gas J.*, 26.12.40, **39** (33), 177.—The paper is a review of progress in drilling practice, and is presented in English and Spanish. The progress reveals improvement and refinement of conventional practices rather than revolutionary ideas or machinery.

Drilling time and bit performance studies are being made standard procedures. In drilling uniform formation the bit should be renewed when R, the rate of penetration in ft./hr., equals

$$\frac{E}{\frac{C}{K} + D + F},$$

where E = total footage drilled by bit; C = cost of bit in dollars; K = cost of rig operation in dollars/hr.; D = round-trip time in hours; and F = drilling time on bottom in hours. Graphical methods of utilizing the equation are explained. Descriptions of bits, their metallurgy, shape of cutters and teeth are given, together with a review of studies on tool-joint wear.

During the past ten years the drilling rate has been speeded up by approximately 500% through the increase of time spent on bottom in relation to overall time of the operation, introduction of better materials, more careful planning of the hole, and decreasing the hole sizes. However, the last factor appears to have reached the minimum within economic limits. Slim-hole drilling practices are reviewed.

Mud fluid circulation and losses are discussed, including the recent use of cellulose fibre or cellophane to drilling mud. Use of chemicals and the type of properties of muds required are briefly studied.

Saving of cable wear in cable-tool drilling may be effected by reducing the weight and increasing the length of the stroke. Drilling speed correlation with depth, for cable-tool drilling, are reviewed.

Multizone completion practices, involving the use and removal of removable casing sections, and the use of radioactive cement and the detection of the height of cement behind casings by use of gamma-ray logging, form the concluding part of this review.
A. H. N.

273.*Practical Drilling-Mud Treatment and Control. C. F. Bonnet and N. A. Howard, Jr. *Oil Gas J.*, 2.1.41, **39** (34), 41–42.—A diagram and an explanation of the surface system required for handling mud are given. The important features of the surface system are: (1) Adequate volume provided by suction pit, mixed-mud storage, and conditioning pit. Gas-cut or cement-cut mud can be diverted to the conditioning pit and its good properties restored before it is used again. In locations where rainfall is heavy, sheet-iron covers for mud pits prevent dilution of mud by rain. (2) Degassing and desanding. In some fields special equipment is installed to eliminate gas or sand. One effective way to remove gas is to have several mud-guns on the conditioning pit for agitation. Fine sand is most effectively removed in a long ditch with a slope not greater than $\frac{1}{2}$ in./ft. If the long ditch is made double width, with a dividing wall, one side can be used at a time while the sand settled in the other side is sluiced into the waste pit with a hose. Settling-pits are not as effective as ditches for sand removal, because mud channels and the pit volume becomes "dead." Chemical treatment of the mud to reduce viscosity and gel strength is essential for degassing or desanding by any method. (3) A separate mixing-pump greatly adds to the flexibility of the mud system and permits independent pumping for mixing fresh mud, conditioning mud, agitation pits, or circulating through degassing equipment.

The paper deals with mud-conditioning practices for shallow and deep wells and with chemical treatment equipment. A. H. N.

274.* Shell-Drills 8200-ft. Wells in California with Tubing. L. P. Stockman. *Oil Gas J.*, 9.1.41, **39** (35), 32.—After drilling the hole with tubing, the tubing is run as casing in the wells. At the present time three wells are being drilled by this method, and a fourth string of tubing is on the rack waiting to be put in use.

The object of this procedure is to eliminate the drill-pipe, an item the cost, maintenance, and repair of which form a large portion of the drilling expense. The tubing is subjected to shock loads while being used for drill-pipe, but is not damaged to an extent which would prevent its withstanding the static load placed on it when used as casing.

The tubing used as a combination drill-pipe and casing is 4½-in. o.d., 3·958-in. i.d., 12·75-lb./ft., upset, Range 2, J.55 tubing having a minimum tensile strength of 95,000 lb./sq. in. The average ultimate tensile strength of a joint is 215,000 lb.; the maximum setting depth is 9880 ft. Couplings on the tubing are 5·563 in. in diameter. The tubing is standard in every respect, except that the threads and couplings are the Acme type, with double-seal joints. Threads are of the six-pitch type with a ¾-in. taper.

In addition to the elimination of drill-pipe depreciation and maintenance costs, the use of the tubing to drill rotary wells reduces the working load on the derrick and hoisting machinery. Formerly, 4½-in. o.d. drill-pipe weighing 16·60 lb./ft. was used. A saving of 3·8 lb./ft. or 30,400 lb. in the total weight of a string of pipe used to drill an 8000-ft. well has resulted from the use of the tubing as a drill-stem.

Very little increase in drilling time has been experienced. Details of drilling, casing, and completion practices are given. A. H. N.

275.* Admixtures and Chemicals Used in Drilling Fluids. H. F. Simons. *Oil Gas J.*, 9.1.41, **39** (35), 34.—Practically all materials used in mud treatment can be divided into five classes: native clays, colloidal clays, weighting agents, chemicals, and

plugging agents. One or all of these may be needed during the drilling of a well. In some cases it may be necessary to replace all the mud in the system, and several of these materials will be used simultaneously. These items are discussed separately.

One reason why native clays are so widely used is their low price. This is a problem which needs close examination by the contractor and oil company, as the investment should be considered in terms of satisfactory mud produced, and not in terms of dry mud purchased. In many cases, materials having a high initial cost are less expensive to use than the cheaper materials. The economy of using native clays must be decided on the merits of the individual case after tests have been made to determine the characteristics of the mud produced.

True bentonite has the ability to become dispersed throughout many times its own weight of water, a colloidal mixture resulting. The suspension formed will have a much greater volume than the water and bentonite which compose it. This fluid will have a high viscosity–weight relationship, will be thixotropic, will deposit a thin but impermeable sheath on the walls of the hole, will have an increased ability to carry the cuttings from the hole, and will readily react with chemical reagents and aid in carrying any weighting material added to the mud.

The most widely used weighting agent is barytes or barium sulphate. It has an average specific gravity of 2. Higher specific gravity of drilling mud can be obtained with barytes if desired.

The use of such chemicals as caustic soda, tannin, complex phosphates, sodium silicate, etc., is outlined in brief. Similarly, plugging agents are studied briefly—any fibrous material, it is stated, may be used. A. H. N.

276.* Treatment of Drilling Fluid to Overcome Difficulties. H. F. Simons. *Oil Gas J.*, 16.1.41, **39** (36), 45.—In normal drilling, where no trouble is anticipated, the mud can be kept at the weight and viscosity which permit the maximum rate of penetration with the least danger. Values at which the weight and viscosity are maintained vary from field to field, and with depth within each field. The viscosity and weight which give the best drilling speed are the permissible minimum; if the drilling fluid is not full of inert material, a light mud having a weight of 9·2–9·5 lb./gall. (69·0–71·2 lb./cu. ft.) and a viscosity of 36 sec. A.P.I. may be satisfactory. Such a mud is easy to pump and will carry the cuttings out of the hole satisfactorily with the pumping equipment used on the average rig.

Difficulties which are encountered every day in all areas where drilling is in progress include: caving, loss of returns, sticking of drill-pipe, high pressure, gas, water, or sat-bearing formations, and high temperatures. In addition, special treatment must be given to the mud while the well is in the process of completion, while coring, formation testing, and fishing are in progress, and in the killing of wells which are about to get or have been out of control.

Each of these difficulties is studied separately, and typical data for the properties of the mud required are included. A. H. N.

277.* Modified Slim-Hole Drilling as Practised in California Fields. W. A. Sawdon. *Petrol. Engr*, Dec. 1940, **12** (3), 91–92.—Although not coming strictly under the category of slim-hole drilling, some recent completions at below 11,000 ft. have been made in the Rio Bravo field with holes and casing diameters somewhat smaller than formerly used. The main considerations taken into account in deciding on these diameters were economics. Other factors are, however, important. To illustrate, it appears that the bit is a governing factor under conditions encountered in the hard formations of this field, as the smaller sizes have not the wear life or bearing strength of the large bits. Thus, the elapsed time in drilling two holes of smaller size was no less than in drilling the large holes, because of the round trips necessary at great depths with the small bits.

Hole sizes and completion programmes are shown on diagrams and given in detail. Cementing the gas sand immediately overlying the oil sand and then perforating and packing off the blank casing thus cemented to produce gas and oil independently are described and illustrated.

Engines, draw-works, and surface equipment employed on the semi-slim-holes were the same as used with the larger holes. In planning slim-hole drilling operations,

it was found that although light-weight casing was used, the difference in load requirements from those of ordinary holes was not much. A. H. N.

278.* **Loss of Cement Slurry Combatted by Use of Cellulose Filler.** G. L. Leach. *Petrol. Engr*, Dec. 1940, **12** (3), 94.—A detailed account is given of many unsuccessful attempts to prevent loss of cement slurry in a particularly permeable region. These included the use of fillers like cottonseed hulls, shredded paper, etc., the use of multiple stage cementing and the procedure involving first cementing around the shoe in the normal manner up to a certain point, and then pumping some 400 sacks of cement through the bradenhead. After these unsuccessful attempts, use was made of a cellulose cement filler which is inert chemically and is an organic product in the form of very thin, yet extremely strong and tough flakes.

Pieces of 0·001-in. thickness and of irregular, varying surface dimensions ranging from ¼ in. to 1 in. appear to be most suitable. Having the density of a drilling mud, this material remains suspended indefinitely in mud or cement slurries. A special chemical treatment imparts a crinkled surface to the flakes, thus preventing them from adhering to each other while either wet or dry. The material is not affected adversely by mud, water, oil, or cement. As no appreciable amount of water is absorbed by the flakes, the effects of the filler on the cement are solely mechanical.

Extensive details are included regarding the properties of the flake, the effects of the filler on the properties of the cement, and tests data on actual cementing jobs.

Excellent results were obtained in all sections of the field in which this filler was tested, excepting in certain cavernous, fissured areas. Circulations were usually lost in that area before cementing was started. In such severe conditions, the old type of bradenhead job was necessitated again.

The flaked material has been used on numerous jobs of plug-backs or squeeze-cementing in porous, highly permeable strata. It has been found particularly successful in previously acidized limestone formations. The quantity of cement required and the number of stages necessary to obtain a desired pressure on squeeze jobs are reduced consistently through its use. A. H. N.

279.* **Suggestions for Improving Design of Marine Drilling Barges.** G. I. McBride. *Petrol. Engr*, Jan. 1941, **12** (4), 23–26.—Against an estimate of $80,000 as the cost of one drilling and one boiler barge, the writer suggests a combined drilling and boiler barge for $30,000. A figure shows a pair of barges of light construction, and a superstructure weighing much less than similar elements in previous drilling barge design. The barges are purposely shallow, in that the closer the centre of mass is brought to the water-line the more stable becomes the unit. Calculations indicate that a 40-m.p.h. wind would tilt the derrick only 2½ in. from vertical, and operations are usually suspended during winds in excess of 40 m.p.h.

Another figure illustrates a drilling barge and boiler barge combined, composed of two shallow hulls, unified, and of inexpensive design. Inasmuch as the barge will float, there is no need to protect the deck-mounted pump compartment. The shallow draft increases the stability, whereas the enormous increase in buoyancy with respect to weight indicates that canals of 5-ft. depth would be ample.

The two barges, each 28 ft. in width, are assembled so that the entire unit measures overall 66 ft. by 160 ft. by 6 ft. deep, which provides a distance of 125 ft. between well and boilers. This in effect could be increased to 140 ft. by further removing stack and draught, but greater distance than this would require lengthened hulls.

Costing and a brief discussion of equipment conclude the article. A. H. N.

280.* **Fineness and Water–Cement Ratio in Relation to Volume and Permeability of Cement.** J. R. Coleman and G. L. Corrigan. *Petrol. Tech.*, Jan. 1941, A.I.M.M.E. Tech. Pub. No. 1266, 1–11.—Other things being equal, it was found that the ratio of set volume to slurry volume increased as the water–cement ratio was decreased, until for any one fineness of cement a definite water–cement ratio was reached at which the ratio of set volume to slurry volume approached 100%. For each fineness of cement there is a definite maximum ("optimum") amount of mixing water that can be used without any "excess" water appearing at the surface during setting. This amount of water was found to increase as the fineness of the cement increased.

There was little difference in the permeabilities of the tops and bottoms of the set cement specimens mixed at low water–cement ratios, *i.e.*, ratios equal to or less than the "optimum" water–cement ratio. Specimens mixed with high water–cement ratios had much higher permeabilities at the tops of the specimens than at the bottoms. The differences in the permeabilities at the tops and bottoms of the specimens decreased as the fineness of the cement increased, and were probably largely caused by settling of the cement particles as the cement was setting. The permeabilities of all the cements increased with the water–cement ratio. Other things being equal at water–cement ratios between 35% and 50%, there was a decrease in permeability with increase in fineness. The permeability of all the cements tested decreased with age or curing temperature, and the rates at which the cements developed impermeability seemed consistent with the rates at which they harden ordinarily. G. D. H.

281.* New Method of Plotting Slant Holes. T. L. Atherton. *Petrol. Tech.*, Jan. 1941, A.I.M.M.E. Tech. Pub. No. 1283, 1–11.—A plan of the path of the well and a vertical projection are drawn on the same sheet, with the plan approximately at right angles to a base line. From inspection of the plans and projections it is possible to tell whether apparent intersections of wells on one of the diagrams (the vertical projections being on the same plane) are intersections in reality, for real intersection involves intersections on both diagrams on the same line drawn parallel to the base line.

If we take a section perpendicular to the course or proposed course of a well, it is possible to plot the intersections of other wells with that plane. If the process is repeated at a greater depth, preferably on a piece of tracing paper, and the positions of the proposed course are superimposed with the diagrams correctly orientated, the trends of the other wells relative to the supposed well are seen for that interval.

The method has been applied at the Tideland pool at Huntingdon Beach, using a "par hole" for control, and it was possible in this way to select new surface locations for draining the sand adequately. G. D. H.

282. Patents on Drilling. J. C. Schellin and E. J. Housekeeper. U.S.P. 2,224,610, 10.12.40. Appl. 4.8.40. Hose coupling construction.

E. Lipson. U.S.P. 2,224,635, 10.12.40. Appl. 28.11.39. Alternating-current method and apparatus for logging wells which are already cased in.

I. C. Bechtold. U.S.P. 2,225,146, 2,225,147, and 2,225,148, 17.12.40. Appl. 10.11.37, 18.3.38, and 18.3.38, respectively. Portland cement manufacture, the cement containing glycol, alcohol ether, or diglycol laurate, respectively. The third cement is called plastic Portland cement.

I. C. Bechtold and H. E. Kaiser. U.S.P. 2,225,149, 17.12.40. Appl. 2.4.38. Portland cement mixture containing a paraffin hydrocarbon-insoluble resin produced by the extraction of pine wood by coal tar hydrocarbon.

I. C. Bechtold and H. E. Kaiser. U.S.P. 2,225,150, 17.12.40. Appl. 14.1.39. Portland cement having air particles mechanically entrapped with the cement, the cement containing a paraffin hydrocarbon-insoluble resin.

W. B. Dunlap, Jr. U.S.P. 2,225,165, 17.12.40. Appl. 16.8.39. Hole under-reamer.

C. C. Gallagher. U.S.P. 2,225,169, 17.12.40. Appl. 22.1.40. Wire rope clamp for wires or cables having a multiplicity of spiral strands each consisting of a plurality of wires.

J. A. Delaney. U.S.P. 2,225,556, 17.12.40. Appl. 22.3.40. Stove-pipe fastening means.

C. L. Henry. U.S.P. 2,225,561, 17.12.40. Appl. 11.7.38. Derrick formed of two independent complementary overlapping sections forming, when secured together, a complete unitary derrick.

P. Subkow and L. Dillon. U.S.P. 2,225,668, 24.12.40. Appl. 28.8.36. Method and apparatus for logging drill holes which are uncased and which contain conductive fluids such as drilling-muds.

Y. Neal and G. G. Hebard. U.S.P. 2,225,709, 24.12.40. Appl. 13.12.37. Apparatus for determining the motion of well drilling tools on a reciprocating vertical line by translating the increase and decrease in line stress on downward and upward motion respectively.

G. E. Mirfield. U.S.P. 2,225,754, 24.12.40. Appl. 2.12.39. Thread protector for pipes.

C. J. Brown and J. C. Haun. U.S.P. 2,225,973, 24.12.40. Appl. 24.8.38. Rotary mud-treatment process to recover the weighting materials by centrifugal separation and froth flotation processes.

C. A. Ricou. U.S.P. 2,226,073, 24.12.40. Appl. 9.10.39. Directional firing casing and formation gun.

A. Boynton. U.S.P. 2,226,547, 31.12.40. Appl. 22.9.38. Semi-threadless drill-stem pipe-connection.

W. J. Beaven. U.S.P. 2,226,655, 31.12.40. Appl. 14.10.39. Rotary bit with blades for cutters.

W. Sheldon. U.S.P. 2,226,947, 31.12.40. Appl. 31.12.38. Well-drilling apparatus having a combination of two crown-block units.

C. S. Piggot. U.S.P. 2,227,198, 31.12.40. Appl. 6.12.37. Core-taking apparatus and method of exposing cores.

J. A. Zublin. U.S.P. 2,227,208, 31.12.40. Appl. 26.6.39. Elastic bit breaker.

J. A. Zublin. U.S.P. 2,227,209, 31.12.40. Appl. 10.10.39. Gyrating rotary bit.

J. A. Zublin. U.S.P. 2,227,210, 31.12.40. Appl. 13.5.40. Drill-bit with non-tracking rollers.

G. L. Scott, J. F. Shaw, and W. B. Noble. U.S.P. 2,227,233, 31.12.40. Appl. 6.4.39. Directional drilling apparatus having a deflecting member telescopically mounted inside the bit.

J. Johnson. U.S.P. 2,227,347, 31.12.40. Appl. 16.6.39. Whipstock for use in casings in deep well-bores.

G. Heinish. U.S.P. 2,227,409, 31.12.40. Appl. 21.6.39. Well-drilling apparatus comprising a spudder arm adapted for oscillatory movement.

R. A. Troman. U.S.P. 2,227,609, 7.1.41. Appl. 12.9.39. Tensioning device for guy wires.

J. J. Santiago. U.S.P. 2,227,763, 7.1.41. Appl. 5.2.40. Expansive reamer.

L. L. Thompson. U.S.P. 2,228,185, 7.1.41. Appl. 2.5.38. Shale separator.

J. E. Hall. U.S.P. 2,228,229, 7.1.41. Appl. 23.9.38. Casing protector applicator tool.

R. C. Baker. U.S.P. 2,228,244, 14.1.41. Appl. 18.3.40. Go-devil adapted to go on a wire line.

W. A. Ross. U.S.P. 2,228,286, 14.1.41. Appl. 5.4.38. Drilling device with conical cutters.

G. E. Prebensen. U.S.P. 2,228,482, 14.1.41. Appl. 18.6.37. Drill-bit.

L. M. Maxwell. U.S.P. 2,228,526, 14.1.41. Appl. 25.3.40. Suction-pipe elevator to be used in connection with well-drilling fluid-pump.

R. S. Kail. U.S.P. 2,228,630, 14.1.41. Appl. 2.7.40. Cementing plug.

J. A. Welles. U.S.P. 2,228,649, 14.1.41. Appl. 17.6.40. Casing centralizer.

A. H. N.

Production.

283.* Practical Use of Subsurface Pressure Measurements in East Texas. N. N. Jones. *Oil Wkly*, 16.10.40, **100** (2), 184; Cf. *Oil Gas J.*, 19.12.40, **39** (32), 30. *Paper Presented Before American Petroleum Institute.*—Different types of subsurface pressure measuring instruments are mentioned, the spring and the Bourdon types being described and illustrated in detail. The data obtainable by using such instruments are: (1) Bottom-hole pressures under static and flowing conditions; (2) Static and flowing gradients or the average weight of fluid/linear ft. in lb./sq. in. between two points of known pressures; (3) The gas–oil contact or fluid level in the well; (4) The water–oil contact in the column of the fluids; (5) The productivity index which is the brl./day of gross fluid produced per lb./sq. in. pressure drop in the producing sand; (6) Specific productivity index or the productivity index divided by the number of feet of producing formation exposed. These items are discussed with particular regard to the behaviour of the reservoir as a unit on the one hand and to the study of individual wells on the other.

Pumping wells may be advantageously studied by finding the level of the fluid above the barrel. For instance, if the fluid level is standing high above the working barrel and the pump is not delivering its known capacity, the fault must be in the pumping element; if the fluid level is near the working barrel, the pump may not be at fault at all, and thus there may be no need to pull the pump or replace it by a larger unit.

Bottom-hole pressure studies in gas-lift wells are of particular importance, and especially with regard to flow-valve installations, and several summarized rules and cautions are presented in the paper in order to facilitate the ready choice of the proper position. To understand these studies, reference to the accompanying graphs is essential.

Cleanout and work-over operations may be put out of the realms of guesswork by bottom-hole pressure measurements. The subject is discussed in some detail; one instance is the necessity to know whether production decline is due to the natural decline in the formation pressure, or due to plugging of liners, casing perforations, or sand-face.

The paper closes with pressure studies in connection with drill-stem tests, as it is the only means of definitely determining whether, under certain conditions, the tester has actually operated as it should do. A. H. N.

284.* Wider Well Spacing. S. K. Clark. *Oil Wkly*, 16.12.40, **100** (2), 14–17.—Wider well spacing has been strongly advocated as a solution for the problem of declining allowables, and has been widely adopted on the premise that it does constitute a solution. The thesis of this paper is a denial of the validity of this premise. Various arguments for wider spacings are discussed, but it is shown that the time factor in development rates is totally ignored, and thus the conclusions reached are mostly fallacious. One such argument is that wider spacing means fewer wells, and consequently solves the problem of declining allowables. However, the problem is that of rate of development, and not of density. Instead of automatically declining, the rate of development may increase with the adoption of wider spacing, if that is coupled with an advantage in allowables.

It is contended that declining allowables are primarily the result of an excessive rate of development, and that stability requires a reduction in that rate rather than a decrease in well density. Only after recognizing these two fundamental factors can the industry study impartially the major economic problem of well spacing.

Summarizing the arguments, it is stated that the application of a time factor in proration would promote true conservation: by aligning the interests of individual operators with those of the industry, by encouraging complete development of existing fields, and by avoiding an excessive rate of development with its economic losses due to excessive investment per brl. of allowable production. A. H. N.

285.* Subsurface Disposal of Oil-Field Brines. K. R. Teis. *Oil Wkly*, 6.1.41, **100** (5), 16.—Common methods of brine disposal when considered on a basis of the ultimate disposition of the brine are classified as: (1) Uncontrolled surface run-off; (2) Con-

trolled discharge to surface streams; (3) Impoundment in surface reservoirs; and (4) Sub-surface disposal.

Physical elements comprising a complete brine disposal system are listed as: (1) The oil separator; (2) The collecting system; (3) The treating plant; (4) The discharge system; and (5) The disposal plant.

The paper is detailed in treatment, particularly so regarding treating of waters and organizing unitary disposal plants. The following conclusions summarize the findings of the author: Subsurface disposal of brine appears to offer most positive, and in many cases the most economical, means of disposal. Utilization of brine input as a means of water flood will become more common. Greater effort on the part of pool operators to bring about this type of operation is recommended. The problem of selecting a subsurface formation for the reception of brine is one of great complexity, and warrants the highest type of technical investigation. The manner in which brine is treated and the degree to which treatment is carried, prior to subsurface disposal, are dependent on purely economic considerations. In most cases complete chemical treatment of brine is not justified. Material reduction in the damage now resulting from escape of oil-field wastes would come from a co-operative approach to the problem, on the part of Government regulatory and enforcement officers. The problem of brine disposal is one common to all those operating on a common water-shed, this being true, a unified plan of regulation and disposal is highly desirable. A. H. N.

286.* Preventing Paraffin Formation by Air Control. F. R. Cozzens. *Oil Wkly*, 13.1.41, **100** (6), 24.—The theory is advanced that air injection may result in paraffin deposition in the sand channels themselves—not only on the face. The problem of removing this paraffin is very difficult, as the cost of injecting solvents is prohibitive.

Operators, however, who have made no such paraffin discovery in their pay-sands can practically eliminate its happening by careful methods of production. It has been proved that the forming of paraffin on the rods and tubing of a well can be retarded greatly by keeping the top closed as much as possible against surface atmosphere. Where any form of air recovery is used, the careful operator will lessen the pressure at the intake wells when the peak of oil production has been passed. Introducing air at several points on a project usually procures a better production and reduces the risk of cutting air-channels through the sand. Abandoned wells should never be left open. Wells being flowed by air should be returned to regular pumping, and pressure reduced as soon as air-pockets begin to appear above the fluid. A. H. N.

287.* Deviation of Natural Gas from Ideal Gas Laws. G. G. Brown. *Oil Wkly*, 6.1.41, **100** (5), 26.—A previous paper by the same author explained the significance of compressibility factors, and this paper illustrates the utility of charts of compressibility factors of natural gas. The first illustration is that of calculating bottom-hole pressures in gas wells from surface measurements of the pressure, specific gravity, and temperature of the gas. The factor is found from the pseudo-reduced temperature and pressure charts and introduced in calculating the increase in pressure in lb./sq. in. from casing-head to bottom of hole. This increase in pressure is equal to the product of density of the gas in lb./cu. ft. for conditions of average temperature and pressure and the depth in ft. divided by 144. The density is equal to $\frac{P}{ZNRT}$, where Z is the factor studied. The method has been checked against numerous measurements of bottom-hole pressures in gas wells and found to agree closely in all cases.

The second illustration is that of calculating gas reserves. If the quantity of gas produced over definite time intervals is known, and the formation pressure can be computed at the beginning and end of each time interval, the gas reserves and the pressure drop accompanying further production may be calculated with satisfactory accuracy by the method described. The method cannot be applied to calculate pressure decline in water-drive reservoirs or when the volume of the reservoir is not constant.

The flow formula for orifice meters is derived from Bernoulli's theorem, intro-

ducing the compressibility factor in the formula at the appropriate place. The accuracy attained is ± 1%, which is better than the accuracy of meter reading and calibration.

The paper ends with a description of constructing enthalpy–entropy diagrams.

A. H. N.

288.* Determination of Factors Affecting Reservoir Performance. M. Muskat. *Oil Wkly*, 13.1.41, **100** (6), 33. *Presented Before American Petroluem Institute.*—The first type of data, and in some respects the most important, which should be gathered in the development of an oil-field is that providing as quantitative an estimate as possible of the original oil reserves. Specifically, the magnitude of the original oil content of the producing formation must be known in order to predict: (*a*) the natural oil recovery and/or (*b*) the advisability or probable success of secondary recovery methods. After establishing the basic characteristics of the mechanics of the production—*i.e.*, whether it is a water-drive, internal gas-drive, or combination-drive field—reasonably accurate recovery factors can generally be applied to the original reserves to predict the natural ultimate recovery. The methods of determining these reserves may be based either on static data or on the production history of the reservoir. The first method simply consists of multiplying the volume of the pay by its porosity and the oil saturation. These items are discussed in detail—but not the methods of determining them empirically.

The dynamical methods are those based on the production history of the reservoir. In their simplest form these methods consist in the extrapolation of directly observed field production data to some point representing the end of the productive field-production data extrapolated graphically until the rates are too low for profitable operation, the area under the rate *versus* time curve life. Such data may be merely giving the ultimate reserves or recovery, or the integrated area—*i.e.*, the cumulative production may be plotted directly against the age of the field, and the ultimate reserves taken as the probably asymptotic maximum of the curve. A more scientific approach involves the additional observation of the reservoir pressures at periodic intervals and observing and extrapolating their decline. This may be carried out by plotting the pressures *versus* the time or *versus* the production rate or accumulated production. Graphical extrapolation to atmospheric pressure or a pre-assigned abandonment pressure again is the means of deciding on the ultimate recovery or reserves. These items are discussed.

Further, the paper deals with data essential to the effective control of reservoir performance under various systems, such as gas-cap repressuring, gas-recycling, or water-flooding operations.

Whilst the data considered and studied are conventional and well known, the treatment of the subject is original.

A. H. N.

289.* New Type Secondary Recovery Developed in St. Louis Pool. T. P. Sanders. *Oil Gas J.*, 19.12.40, **39** (32), 39.—By installing large-volume pumps to handle the water which has encroached into the Simpson dolomite oil zone, trapped oil which would otherwise have been lost is washed into the wells. Then, after the head on the encroaching water has been lowered through removal of liquid, the gas remaining in structural, stratigraphic, or porosity traps is allowed to expand, thereby forcing additional oil to the low-pressure areas about the well-bores. So successful has been this method of extending the productive life of the pool that about 180 new wells have been drilled as a direct result.

The economies of this system are briefly discussed, as arguments have been produced that cheaper methods of production could have been used, had the operators waited for the oil to accumulate at the crest of the structure. These arguments are not supported, as certain evidence indicates that the system is sound economically. Millions of barrels of oil are now potentially recoverable by this system; they would have been a total loss under former production practices.

There is evidence to indicate that this type of secondary recovery could be applied profitably to many of the typical limestone and dolomite reservoirs in their late productive lives.

A. H. N.

290.* Barge Developed for Servicing Wells in Lake Maracaibo. L. A. Sucre. *Oil Gas J.*, 26.12.40, **39** (33), 125.—In addition to routine servicing duties, the common types of operations performed on wells on the eastern shores of the lake are, in order of frequency of occurrence: (1) Rod and tubing jobs; (2) Cleanouts; (3) Pump replacement; (4) Standing valve-depth adjustments; (5) Washing of screen liners; (6) Back plugs; and (7) Placing of insert liners. As more pumping wells were being operated, it became economically preferable policy to provide mobile servicing units instead of the old one of providing individual equipment to each well. The historical development of the mobile systems is reviewed, until the present-day use of a barge specifically built for servicing wells.

The details of the barges used for such purposes are illustrated and studied, and it is noted that the draft of these vessels is of particular importance, since a variation of an inch or two is frequently the determining factor in the selection of a barge suitable for locations in very shallow water.

All barges are towed by tugs or launches, and come into the location on the V-side of the derrick. The method of bringing the barges in is briefly described.

For well-servicing at night all barges are equipped with individual light-plants to generate power for all lights on the derrick and on the barge itself. Advantages of using these barges are detailed. A. H. N.

291.* Trends in Production Practices. Anon. *Oil Gas J.*, 26.12.40, **39** (33), 194.—In this English–Spanish review of production methods acid treatment of wells is the first subject to be studied. A 1000-gal. treatment of 15% acid will dissolve approximately 10 cu. ft. of limestone. The result of treatment must not be merely enlarging the hole; acid should penetrate the strata. The use of acid-jet guns with 1000 lb./sq. in. differential pressure drop across the jet is described, and nine purposes for which the gun may be employed are listed.

Gas-lift occupies the next portion of the paper, intermittent gas-lift and intermitter design and installation featuring the main study.

Flowing wells are next studied, and the waste of energy involved in too slow rates of flow is strikingly illustrated by the leak in a gas-charged water-bottle, which results in the total escape of gas without the use of its energy being effected, and leaving dead fluid in the bottle. The tubing in large-capacity wells act as separators when the flow is reduced below certain critical values. Shutting the well for part of the day and flowing the well at optimum capacity for another part is often more economical than a 24-hr. flow-period at too low rates of flow. For determining the best rate of flow there is no better gauge than gas–oil ratio.

High-temperature cooling of engine cylinder walls is next discussed, and the advantages and difficulties accruing from such practices are pointed out. Vapour-phase cooling can increase engine efficiency 3% or 4% under full load, or up to 8% or 10% under partial load. The effect of sulphur in the combustible fluid on the engines is studied under high- and low-temperature cooling conditions.

The device used in stripper leases to disconnect wells from central power-stations automatically whenever pound is serious is described in some detail.

Pumping-wells and beam-pumping systems are reviewed. The tendency is towards more efficient design practices than has been practised hitherto.

Secondary recovery methods and re-cycling operations are studied in the concluding portion of the paper. Theory and practice are both reviewed in brief.
A. H. N.

292.* Fundamentals and Cures for Gravity Losses in Production and Handling of Crude Oil. C. Glasgow. *Oil Gas J.*, 2.1.41, **39** (34), 46. *Paper Presented Before American Petroleum Institute.*—Significance of different scales of gravity is first explained, and it is then noted that a loss of 1° A.P.I. means a volumetric loss of 2½% for oils having gravities between 30° and 42° A.P.I. From various investigations it is safe to estimate that the average loss for all the oil produced in the U.S.A. from the time this oil reaches the surface of the ground until it enters the refinery is approximately 1° A.P.I. The average daily production in the U.S.A. is approximately 3,500,000 brl. A loss of 1° A.P.I. or 2½% in volume on this amount results in a daily loss of 87,500 brl.—*i.e.*, approximately 32,000,000 brl. of the most valuable part of the crude oil is lost every year. Figuring oil at an average price of $1/brl.,

and 2 cents/brl. loss due to changing oil to a lower gravity bracket, would result in an annual loss of $32,640,000.

Vaporization is briefly discussed from a theoretical viewpoint, showing that the net result of vaporization in tanks is raising the density or lowering A.P.I. gravity of the oil. The five controlling factors that govern vaporization are: (1) Temperature; (2) Pressure; (3) The percentage of the surface area (mol. fraction) covered by the component; (4) Molecular energy of the component (vapour pressure); and (5) Total surface area exposed where vaporization can take place.

In the production and handling of oil the only places where gravity can be lost is where the vapours are released and carried away from the liquid crude. Principally speaking, there are only four places in the normal methods of handling crude from the time the crude leaves the well until it reaches the refinery where vapours are separated from the original crude. They are: (1) Separator; (2) Treating equipment, where used; (3) Field stock-tanks; and (4) Pipe-line storage.

Methods of reducing losses in each of the four items are discussed in a fairly detailed manner. A. H. N.

293.* Calculating Percentages in a Two-Component System. T. W. Brinkley. *Oil Gas J.*, 9.1.41, **39** (35), 37.—A copyrighted chart is presented for calculating percentages of oil and salt water in two-component mixtures. The chart is not limited to salt water–oil mixtures, but applies to any percentage or factor problem following the law of $P = A/(A + B)$. A. H. N.

294.* Hot-Acid Treating is Latest Acidizing Development. D. G. Hefley and J. Sutherlin. *Oil Gas J.*, 16.1.41, **39** (36), 52.—A new acidizing technique has been developed which makes possible the introduction of hot acid into a formation. In this method the heat of reaction between magnesium and hydrochloric acid is utilized. The actual temperature to which the acid is heated can be regulated by the amount of magnesium used, or by the pumping rate of the acid.

Acid has been heated at the surface in various ways, but these have been discarded because of inefficiency, excessive cost, or undue amount of time involved. The biggest fault with any such procedure is that much of the heat of the hot acid is lost before the acid reaches the well bottom, due to heat exchange between the acid and the well equipment and formation. The circulation of hot oil before an acidizing treatment has also been tried as a method of heating up the formation itself, but this generally has been unsuccessful because of the enormous heat-exchange losses.

In the new successful method of introducing hot acid into the formation, magnesium metal is placed in the tubing near the bottom of the well, and acid is then pumped into the tubing. The reaction between magnesium and hydrochloric acid is exothermic, being accompanied by the evolution of a great amount of heat. Thus, when the acid reaches the bottom of the well, some of it reacts with the magnesium, thereby heating the main body of the acid immediately before it enters the formation.

Advantages of the system are detailed.

It is very important that any well treated with hot acid in a regular formation treatment be capable of taking fluid at a fairly fast injection rate; otherwise the acid could not be pumped into the well fast enough to control the temperature of the acid, with the resulting possibility that acid might be heated more than desired.

Hot acid may be used in wells with restricted passages due to wax deposits, and also to remove metallic oxides and sulphides from well-screens. A. H. N.

295.* Water Injection in Oil-Producing Operations of South-East Kansas. P. Reed. *Oil Gas J.*, 16.1.41, **39** (36), 54.—Operations of three different types are employed for dealing with water injection: (*a*) where water-flooding of sands is being conducted at depths considerably below those customarily exploited in Mid-Continent water-flooding; (*b*) in properties where water is disposed of by injection in the ground in such a manner that oil production is increased; (*c*) water is disposed of in old wells where decline of production is checked. Most conspicuous features of these operations which are to be observed on a field trip are described in this article.

Results obtained in water-flooding in one property provide a demonstration of water-flooding operations conducted at a greater depth than is customary in Mid-

Continent practice. The five-spot spacing of 660 ft. is considerably greater than the 330 ft. and 440 ft. spacing which is widely used. Reports of water injected and oil recovered show that during the water-flooding history of the property 8 brl. of water have been injected for each barrel of oil recovered. This compares favourably with 10 : 1 ratio which prevails at numerous Mid-Continent flood projects, and it is believed that the ratio may be lowered as the result of planned changes in method of operation.

Flooding operations in other properties are also described. A. H. N.

296.* Estimating Availability of Natural Gas Reserves. P. C. White. *Petrol. Engr*, December 1940, **12** (3), 23–28.—When the relationship $[Q = C(P_f^2 - P_s^2)^n]$ is plotted on logarithmic scales a straight line is obtained connecting Q, the rate of flow, and P_f and P_s the absolute formation pressure and the sand-face pressure, respectively. That this relationship is relatively constant throughout the life of the gas well, provided the physical conditions remain the same, has been proved by numerous periodic pressure tests made on gas wells throughout the U.S.A. by gas companies, the U.S. Bureau of Mines, and many State conservation commissions.

The paper uses this relationship to expand and refine the methods already set out by the U.S. Bureau of Mines (Monograph 7, 1935) regarding the availability of gas reserves. Four functional values are defined and derived. These are the weighted average absolute pressure, the total absolute open-flow capacity, the weighted average pressure-flow curve, and the weighted average absolute formation abandonment pressure. Further, certain other basic data which are necessary before proceeding with the availability studies are defined and explained.

An hypothetical example is worked out for twenty gas wells located in three separate gas-fields, which are supplying an integrated pipe-line system, and the time of failure to meet the demands is forecast together with the proportion of the demand it will be possible to meet at such a time. A. H. N.

296a.* Practical Application of Planned Optimum Rate Proration. Part I. A. M. Crowell. *Petrol. Engr*, December 1940, **12** (3), 37–40.—Proration by optimum rate is defined as the employment of engineering technique to the end that the output of each pool be restricted in such manner as most advantageously to make use of the inherent energy of each pool. Economic and other factors come into the problem in practice and equity must therefore be considered also.

To define the limits of a pool, dry holes have had to be drilled; but this practice is becoming increasingly unnecessary by adopting sound engineering methods. Further, when a specified unit comprises two or more separately owned tracts of land, it is required that such ownership be embraced as a unit by integration. One would be designated to develop and operate the unit, and the other owners of production would be charged their pro rata part of the expense.

The source of energy by which oil is produced is of special importance in any field. The pressure differential between various parts of the reservoir and the well-bore may result from either a water-drive or from the force of expanding gas. The significance of each source of energy is discussed.

Significance of bottom-hole pressures is next discussed and a chart illustrates their use.

The paper discusses, in fact, the State-supervised proration in the State of Arkansas, and concludes that equity is attained. A. H. N.

297.* Unique Pressure Maintenance Project at Loudon. C. G. Herrington. *World Petrol.*, December 1940, **11** (13), 38–45.—In addition to its importance from a producing standpoint, the Loudon Pool is the location of one of the industry's outstanding large-scale gas-injection projects. Matching the revolutionary character of the Pool's general development programme, which is based on the use of removable casing sections in the completion of multi-sand wells, this gas injection employs the most modern practices. It is achieving the anticipated results simultaneously with the solving of many complex producing problems inherent to the operation of any pool having a multiplicity of producing formations.

Edge-water encroachment has become evident in areas of high volumetric with-

drawals, and especially in the southern portion of the pool; however, an active water-drive does not exist, and the pool is essentially one of gas-drive characteristics.

The tightly cemented, compact pay formations require shooting with nitro-glycerine to obtain satisfactory production rates. The exposing, and producing after shooting, of all of the sands in a common well bore were made possible by extensive experimentation in well-completion practices, which culminated in the widespread use of special casing sections. These alloy sections may be placed in the regular casing string opposite the upper formations, and later removed, when desired, by milling, acidizing, or shooting directly with nitro-glycerine.

In the past, re-pressuring has usually been applied to reservoirs which had been practically depleted under normal production methods, and has amounted merely to supplying the area with a differential pressure which tended to drive the almost gas-free oil from the pore-space in the formation to the producing wells. The Loudon re-pressuring project differs to the extent that it was inaugurated at the very beginning of the pools development to stimulate the natural movement of reservoir fluid while it was still in its most fluid state. Also, the volume of gas available is limited and conservation of the meagre supply is necessary.

Graphs and photographs illustrate the operations and results obtained from re-pressuring. The multiplicity of erratic producing formations as encountered in the Loudon Pool and the modern practice of completing the oil wells in such a manner as to produce, in the open hole, two or more sands tend to make this one of the most complex gas-injection projects now in operation in the industry. A. H. N.

298.* Effects of Pressure and Temperature on Condensation of Distillate from Natural Gas. S. E. Buckley and J. H. Lightfoot. *Petrol. Tech.*, January 1941, A.I.M.M.E. Tech. Pub. No. 1269, 1–13.—In the presence of natural gas the solubility in the gas-phase of the heavier and normally liquid hydrocarbons increases rapidly with increasing pressure above 500–1000 lb./in.^{2} Thus, at 2500 lb./in.^{2} or more, there may be appreciable amounts of hydrocarbons normally boiling up to 600° F. which condense on reducing the pressure. Certain limitations, experimental and otherwise, have prevented the construction of even approximately complete phase diagrams for naturally occurring systems. Hence, through using over-simplified diagrams there has been a failure to appreciate fully some of the implications involved in dealing with the complex mixtures which issue from reservoirs.

To obtain quantitative data on the limitations attending the recovery of distillate from natural gas by pressure and temperature control, a portable plant has been devised to operate at 0–2000 lb./in.^{2} and $-40°-+80°$ F., using 500,000 cu. ft. of gas/day. Part of the gas produced by the well was taken off and passed through the plant.

It was shown that, in addition to the commonly observed pressure of maximum liquid yield for a fixed temperature, there exist also, at pressures of 1000 lb./in.^{2} and higher, temperatures of maximum liquid condensation. Below these optimum temperatures the amount of condensate decreases rapidly, and finally vanishes. The results indicated that most gas-distillate systems are probably characterized by low critical temperatures and pressures, from which it may be expected that most of them will exhibit optimum separation temperatures at certain pressures and optimum separation pressures at all temperatures normally encountered.

The experimental plant and procedure and the analytical technique are described. G. D. H.

299.* Some Theoretical Considerations on the Problem of Well-Shooting. H. H. Evinger and M. Muskat. *Petrol. Tech.*, January 1941, A.I.M.M.E. Tech. Pub. No. 1268, 1–13.—Theoretical and experimental investigation of well-shooting is extremely difficult. However, by making certain simplifying assumptions, numerical values have been obtained which give some idea of the magnitude of the effects to be expected. The explosion process and its effects are described. Assuming that the maximum pressure varies directly with the concentration of the explosive, it is found that for static pressures in the cases of cylindrical and spherical cavities the fracturing radius varies respectively as the square root and cube root of the size of the charge. If the time rate of pressure application is considered for the spherical

cavity the fracturing radius varies approximately with the first power of the size of the charge.

It appears that tamping with solids instead of liquids will protect the casing, and tamping may increase the fracturing effect of a shot.

Various suggestions are made for experimental investigation of the effect of the quantity, nature, and distribution of the explosive. G. D. H.

300. Patents on Production. H. H. Holmes. U.S.P. 2,224,297, 10.12.40. Appl. 13.4.39. Treatment of wells to increase their fluid flow, by introducing a material the *p*H of which is between 3·5 and 7·0 and which is incapable of forming a water-insoluble hydroxide.

S. V. Smith. U.S.P. 2,224,412, 10.12.40. Appl. 6.2.40. Perforation cleaner for oil-wells possessing cleaning members which may be moved bodily outward on a carrier.

J. E. Eckel and C. E. Reistle, Jr. U.S.P. 2,224,538, 10.12.40. Appl. 2.6.39. Method and apparatus for gravel packing wells by means of tubing and a valve which may be opened at will.

C. J. Dean and F. B. Carter. U.S.P. 2,224,630, 10.12.40. Appl. 11.9.39. Screen-pipe with fragile lining which may be made to collapse by applying external pressure, the pipe being for use in gravelling wells.

L. L. Mackowski. U.S.P. 2,224,826, 10.12.40. Appl. 11.3.38. Anchor for insert pumps in wells.

G. W. McFarlane. U.S.P. 2,224,916, 17.12.40. Appl. 15.10.37. Well-swab which consists of two swabs mounted in tandem.

R. C. Baker, C. E. Burt, and T. M. Ragan. U.S.P. 2,225,143, 17.12.40. Appl. 13.6.39. Well-packer mechanism.

W. W. Brown. U.S.P. 2,225,153, 17.12.40. Appl. 21.3.39. Manifolding apparatus.

T. B. Wayne. U.S.P. 2,225,189, 17.12.40. Appl. 29.7.38. Process and reagent for resolving emulsions of petroleum and consisting of a water-wettable polyamine compound.

C. S. Crickmer. U.S.P. 2,225,208, 17.12.40. Appl. 20.4.39. Pipe-coupling.

B. J. Festervan and N. F. Henderson. U.S.P. 2,225,413, 17.12.40. Appl. 19.10.38. Paraffin scraper for removing paraffin from the inside of a vertical oil-carrying tubing, the scraper being a buoyant body with a cutter.

J. J. Harrigan. U.S.P. 2,225,434, 17.12.40. Appl. 20.10.38. Method for treating oil-wells to remove deposited paraffin encrustation from the casing and ground lines of oil-pumping and gathering equipment.

R. H. Carr, G. G. Hebard, G. M. Henderson, and G. Heinish. U.S.P. 2,225,683, 24.12.40. Appl. 3.12.37. Apparatus for use in connection with earth boring, consisting of an indicator with means of obtaining straight-line motion in two directions, at right angles to each other.

L. M. Henderson, G. W. Ayers, Jr., W. A. Raine, and W. B. Ross. U.S.P. 2,225,695, 24.12.40. Appl. 30.11.36. Method for increasing flow of deep wells in siliceous formations by injecting inhibited hydrofluoric acid.

D. L. Garrett. U.S.P. 2,225,775, 24.12.40. Appl. 26.1.40. Apparatus for de-paraffining oil wells by the production of a heated gaseous fluid in the well.

M. De Groote and A. F. Wirtel. U.S.P. 2,225,824, 24.12.40. Appl. 21.12.38. Process for resolving petroleum emulsions of the water-in-oil type.

E. O. Bennett. U.S.P. 2,225,949, 24.12.40. Appl. 3.8.36. Method of removing oil from wells and subjecting them immediately to gaseous- and light-fractions-separation to eliminate weathering losses due to gauging.

M. De Groote. U.S.P. 2,226,118, 24.12.40. Appl. 18.8.39. Process for resolving petroleum emulsions of the water-in-oil type.

M. De Groote and B. Keiser. U.S.P. 2,226,119, 24.12.40. Appl. 6.3.40. Flooding process for recovering oil from subterranean oil-bearing strata using an aqueous solution of a water-soluble, surface-active, alkaline earth-resistant polyglycol ether.

M. De Groote, B. Keiser, and A. F. Wirtel. U.S.P. 2,226,120, 24.12.40. Appl. 12.5.39. Process for resolving petroleum emulsions of the water-in-oil type.

M. De Groote. U.S.P. 2,226,121, 2,226,122, and 2,226,123, 24.12.40. Appl. 12.5.39, 12.5.39, and 23.10.39, respectively. Processes for resolving petroleum emulsions of the water-in-oil types.

A. W. Steenbergh. U.S.P. 2,226,537, 31.12.40. Appl. 8.3.40. Gas-lift apparatus with a liquid collecting chamber adapted to be placed in a well.

J. S. Carroll. U.S.P. 2,226,804, 31.12.40. Appl. 5.2.37. Liner for wells comprising sections of crushable perforated pipe.

S. A. Guiberson. U.S.P. 2,227,132, 31.12.40. Appl. 27.1.38. Removable pumping mechanism for wells.

T. B. Losey, Jr. U.S.P. 2,227,192, 31.12.40. Appl. 15.2.38. Apparatus for testing oil-wells fluid content of the strata and its nature.

J. G. Campbell. U.S.P. 2,227,438, 7.1.41. Appl. 24.9.38. Method of determining the petroleum-oil content of earth samples.

H. T. Dorton. U.S.P. 2,227,538, 7.1.41. Appl. 8.5.39. Apparatus for flowing-wells.

H. T. Dorton. U.S.P. 2,227,539, 7.1.41. Appl. 24.10.39. Apparatus for flowing-wells.

M. S. Haslam. U.S.P. 2,227,545, 7.1.41. Appl. 20.11.39. Combination Packer-washer and well-booster.

J. Lynes. U.S.P. 2,227,729, 7.1.41. Appl. 30.9.39. Packer and sampling assembly.

J. Lynes. U.S.P. 2,227,730, 7.1.41. Appl. 13.10.39. Inflated packer treating tool for wells.

J. Lynes. U.S.P. 2,227,731, 7.1.41. Appl. 15.3.40. Well-formation testing and treating tool.

L. C. Morgan and T. J. Stewart. U.S.P. 2,227,860, 7.1.41. Appl. 22.7.38. Well-treating fluid and method of application.

A. Pranger. U.S.P. 2,227,912, 7.1.41. Appl. 22.9.39. Control-head packer.

R. W. Darden. U.S.P. 2,228,003, 7.1.41. Appl. 20.2.39. Rocker-arm bearing.

R. C. Baker, C. E. Burt, and T. M. Ragan. U.S.P. 2,228,241, 14.1.41. Appl. 5.5.39. Well packer.

R. C. Baker. U.S.P. 2,228,242, 14.1.41. Appl. 25.7.39. Debris pusher and catcher for well-packers.

R. C. Baker. U.S.P. 2,228,243, 14.1.41. Appl. 23.12.39. Releasable coupling for well-packers adapted to be anchored in a well-casing.

J. J. Klise. U.S.P. 2,228,318, 14.1.41. Appl. 13.10.39. Aerating device for well-tubing.

F. C. Boyd, E. Burns, and F. A. Pilgrim. U.S.P. 2,228,503, 14.1.41. Appl. 25.4.39. Liner hanger.

E. L. Barker. U.S.P. 2,228,555, 14.1.41. Appl. 10.3.38. Means for securing casing in a well.

G. H. Ennis. U.S.P. 2,228,623, 14.1.41. Appl. 25.6.40. Method and means for locating perforating means at producing zones.

W. M. Jarrell. U.S.P. 2,228,629, 14.1.41. Appl. 20.12.38. Method of treating oil- and gas-wells to remove accumulation of paraffin, shale, or rotary mud, etc., by means of a charge of aluminium and caustic.

F. E. O'Neill. U.S.P. 2,228,640, 14.1.41. Appl. 11.12.39. Casing washer.

M. De Groote, B. Keiser, and C. M. Blair. U.S.P. 2,228,986, 2,228,987, and 2,228,988, 14.1.41. Appl. 23.2.38, 19.4.38, and 28.4.38, respectively. Wetting, emulsifying, and dispersing agents. A. H. N.

Transport and Storage.

301.* Practical Application of Electrolysis Prevention on Pipe-Lines and in Compressor Station. Part I. P. F. Marx. *Petrol. Engr*, January 1940, **11** (4), 41.—The application of cathodic protection with particular reference to the prevention of corrosion in compressor stations is reviewed. The choice of wire for generator leads and bonding from the point of view of effectiveness and expense is discussed. An inexpensive bonding machine is illustrated. A cast-iron rod is recommended for attaching the coupling bonds to the pipe. The selection of a suitable site and the installation of ground beds are described. T-rails are recommended for use in the ground-bed design. A chart for recording cathodic protection data and a drawing of a complete wind-driven cathodic unit are included. R. J. E.

302.* Determining Minimum Current Required to Provide Adequate Cathodic Protection. Part II. D. Harrell and M. Clere. *Petrol. Engr*, January 1940, **11** (4), 64.—In Part I (Abs. No. 282) the authors arrived at a theoretical value of half-cell protective potential between pipe and soil of $-0{\cdot}2853$ volt at 25° C. Part II gives a detailed description of the method adopted for the experimental laboratory determination of the protective potential. The results obtained with different solutions show that the potential does not vary with a change of solution. Close agreement with the theoretical value was obtained in all cases. The greatest influencing factor on the protective potential is temperature. The relation protective potential–temperature is a straight-line curve, and the potential at a temperature 1° C. is given by the equation $Ep = -0{\cdot}2854 - 0{\cdot}00096\,(t - 25)$. R. J. E.

303.* Practical Application of Electrolysis Prevention on Pipe Lines and in Compressor Station. Part II. P. F. Marx. *Petrol Engr*, February 1940, **11** (5), 51.—Electrolysis conditions and consequent corrosion of pipes may occur at compressor stations using battery ignition systems. This electrolysis is due to the grounding of the primary ignition system. This condition is rectified by insulation, so that there are no ground points in the primary circuit. The wiring system adopted for the purpose is illustrated.

The procedure used for making soil and pipe-line inspection surveys is described, and comprehensive charts for recording the data are illustrated. Definitions of the terms used in field inspection sheets are included. R. J. E.

304.* Review of Recent Contributions to Study of Pipe-Line Corrosion. D. Harrell. *Petrol. Engr*, Midyear 1940, **11** (10), 127.—Four recent papers on the subject are summarized. The first, by G. N. Scott, was presented at the Petroleum Industry Electrical Association meeting at Dallas in May 1940; the other three at the American Gas Association's convention in Houston.

(1) *Application of Electrical Protection.* G. N. Scott. This paper dealt with the application of electrical protection to pipe-lines, and curves were shown representing actual measurements on various lines under dissimilar conditions, but based on the relationship :—

$$V_r = V_o + ki\rho \log r$$

where V_r is the measured potential at point r from the line, V_o the polarization potential, k a constant, i the current density, and ρ the resistivity of the homo-

geneous environment. Hence, from knowledge of resistivity and potential produced by a unit saturation current, it should be possible to predict the current density necessary to bring any section of the pipe to electrical protection, and thus place on a scientific basis the estimation of the current required for protection.

(2) *Results Obtained with Cathodic Protection.* F. A. Hough. This paper dealt with the answers to questionnaires submitted to various companies in connection with their experiences of cathodic protection of pipe-lines during the last 5–7 years. The replies showed that, in spite of various difficulties in individual aspects, in general the method is of great service, and cathodic protection may be considered an essential part of pipe-line equipment.

(3) *Determination of Current Required for Cathodic Protection.* S. Ewing. Current density/solution potential relationships were given for Zn, Mg, Fe, Ni, Ag, Pt. It was also shown that the minimum protective value is that at which the plot of log current density/cathode potential abruptly changes from a curve to a straight line. This portion of the curve, called the over-voltage curve, was nearly always obtained with steel electrodes in soil. The author also presented data on the effect of alkali on the current density/potential curve in both aerated and unaerated soils, and on what occurred when the alkali concentration was not maintained. In general, the protective current caused alkali to accumulate on the protected surface. If there was sufficient oxygen, an oxide film was formed, and hence the potential became more positive. In the absence of oxygen, accumulation of alkali caused the potential to shift in the negative direction.

In the absence of metallic ions, the effect of the current was to cause consumption of oxygen at the cathode, provided it was supplied in limited quantities. Beyond this saturation point hydrogen was evolved and plated out on the cathode until the latter became covered with hydrogen, when it functioned as a hydrogen instead of an iron electrode.

(4) *Studies in Microbiological Anaerobic Corrosion.* R. F. Hadley.—The author suggested the real cause of pipe-line corrosion was *Sporovibrio desulfuricans*. Assuming that as long as the cathode is plated with hydrogen no corrosion occurs, the paper developed the theory that the micro-organism removes such hydrogen through a metabolic process under anaerobic conditions. *Sporovibrio desulfuricans*, however, in order to sustain the process of multiplication and growth, requires the presence of oxygen in a salt, such as $CaSO_4$. This is reduced to CaS, which reacts with the pipe-line to give FeS, a product which is always found where there is extensive corrosion accompanied by the organism in question. It is also necessary for the growth of the organism that hydrogen donors should be present; these include fatty acids, alcohols, etc., and the decomposition products of cellulose.

The author considered that cathodic protection hindered the growth of the organism, for in spite of the fact that it increases the available hydrogen, the latter is produced in the molecular form which is least easily assimilated by the organism. Further, the consumption of oxygen at the cathode may tend to remove the sulphate essential for reproduction, and the increased p_H of the soil is also unfavourable to the organism. T. T. D.

305.* Careful Cost Study leads Gas Company to Selection of Cathodic Protection. H. C. Gear. *Petrol. Engr*, August 1940, **11** (12), 29.—The experience of the Lone Star Gas Co. has shown that external corrosion is not uniformly distributed, but is confined to relatively small sections of the lines. In one bad section of 3½ miles length, careful recording of all repairs required showed that the time/repair relationship is represented by $y = ax^n$, where x is total number of repairs in y years. Thus once the pipe has got into a bad condition, the rate of deterioration increases rapidly.

The estimated annual cost of methods of combating corrosion (including depreciation of capital investment) is:

(1) Repairs and replacements made as necessary .	$4000
(2) Reconditioning 3½ miles pipe-line . . .	$2575
(3) Cathodic protection	$1592

From the economic standpoint (3) is most desirable, and was put into effect. All couplings were bonded with copper wire, which was welded to the pipe at each end and at the centre ring. Power was provided by three natural-gas engines generating

2000 watts, with a maximum output of 100 amp. and a voltage range of 5–35. The anodes were placed 500 ft. from the line, and were of the vertical type, consisting of 8-in. vertical legs 30 ft. long, spaced 30 ft. apart, and tied together by a 6-in. header.

From the potential survey taken after the units had been in operation 10 days, a very flat curve was obtained, showing that only a few short lengths of line were unprotected. It is anticipated that as the line becomes polarized, these areas will undergo a rise in potential, and become satisfactorily protected. T. T. D.

Hydrogenation.

306.* Hydrogenation of Petroleum Fractions, Employing a Large Percentage of Catalyst. H. I. Waterman and C. Van Vlodrop. *J. Inst. Petrol.*, September 1940, **26** (203), 452–456.—By using large quantities of catalyst, nickel on kieselguhr in the ratio of 1 nickel to 5 kieselguhr, it is found that even dark and asphaltic oil fractions or residues are converted into completely colourless saturated products by subjecting them a certain number of times to the hydrogenation process. A. H. N.

307. Patent on Hydrogenation. J. G. Fife. E.P. 530,253, 9.12.40. Appl. 1.6.39.—Production of branched-chain hydrocarbons by the hydrogenation of unsaturated aliphatic hydrocarbons. The mixture of saturated hydrocarbons and hydrogen thus produced is freed from carbon monoxide and sulphur compounds and afterwards isomerized by treatment with aluminium halides. H. B. M.

Synthetic Products.

308.* Factors in the Synthesis of Kogasin and Paraffin in water-phase. F. Fischer and H. Pichler. *Refiner*, December 1940, **19** (12), 479–481. Translated from *Brennstoff-Chemie*, 1939, **20** (13), 247.—The most difficult factor to control in the Kogasin synthesis is the temperature, which should be held within quite narrow limits. This requirement is generally difficult to attain, due to the strongly exothermic nature of the reaction: $CO + 2H_2 = CH_2 + H_2O$. The liberated heat of reaction must be carried away continuously without allowing any falls of temperature. The most important procedures adopted are: (1) Circulating oil outside of the catalyst chamber; (2) Catalyst suspended in paraffin oil (oil-phase); (3) Circulating superheated water outside the catalyst-chamber, viz. about 180° C. (at about 10 atm.); and (4) Catalyst suspended in superheated water (180° C. at 10 atm.), water-phase.

The four items are discussed, the first three briefly. Commercial technique uses the third procedure for many obvious advantages.

The fourth procedure is discussed in greater detail than the rest, and, in fact, the paper consists of reporting results of experiments in the water-phase.

To keep the catalyst in suspension, the horizontal pressure vessel contains a stirrer made of copper—a blade almost as wide as the internal diameter of the vessel, and which blade is perforated with many small holes to aid in thorough mixing. The blade or stirrer fits almost snugly into the vessel. This blade stirred the catalyst into a strong turbulent motion, keeping the former well suspended and well mixed with the gas mix without offering too much friction for the gas passage. The speed of stirring controlled the conversion to a great degree; the faster stirring action always giving greater yields. A limit is reached when too great a speed throws the catalyst in the suspension into the cooler. Usually 120 r.p.m. was found to be efficient. Attached to the vessel is a pressure cooler from which the exit gases could be released through a valve. The water and the non-volatiles flow back into the reaction vessel from this cooler.

Results of experiments in which different catalysts were used (nickel, cobalt, iron, ruthenium) are reported. A. H. N.

Refining and Refinery Plant.

309.* Open-Type Cooler. F. L. Kallam. *Refiner*, October 1940, **19** (10), 371–382.—Foremost amongst the advantages of the open-type cooler is the feature of ready accessibility for cleaning and replacement of tubes, and the fact that the water

requirement of such coolers is relatively low. These shop-fabricated cooling sections are vastly superior when compared to the use of pipe for similar service, principally from the standpoint of first cost, performance, weight, salvage value, area, and volume occupied.

Exaggerated claims have often been made for the ability of this type of equipment to shed scale, particularly when the tubes are given an initial bowing. Supposedly, interrupting the flow of cooling water for a brief period, while allowing the hot fluid to continue to flow within the tubes, will cause sufficient tube distortion to crack off the scale which may be present. Stopping the water supply to the equipment and passing steam through the tubes as a heating medium, followed by sudden chilling of the surface by reapplication of the water, will result in a similar effect. Actual experiment and experience, however, have shown that in the greater number of cases these measures will not cause the scale to fall completely from the metal surfaces as claimed.

One advantage which the open type has is that the scale formed from the cooling water under the operating conditions can be removed mechanically, and if need be this can be done without placing the equipment out of service.

The fact that open-type coolers can be operated for long periods with considerable amount of scale on the tubes without affecting the pumping constitutes a hidden source of loss of production. Thermal efficiency is reduced without its being detected, and the loss is often greater than the gain, due to long periods between cleaning operations. Other disadvantages are discussed.

To understand the functioning of the open-type cooler, it is first necessary to recognize the cardinal principle that the heat removed is ultimately dissipated to the air. If the tubes are flooded with water it may be assumed that no evaporation takes place and that all the heat is removed by raising the temperature of the water. Should it be desired to recirculate this heated water, as in the usual case, it is re-circulated over the top of the cooling tower, where the heat it contains is released to the air.

When a smaller quantity of cooling water is employed to remove the heat it is necessary to evaporate this water from the exterior of the tubes and to transmit the heat to the surrounding air. This air is caused to flow past the cooler section by either natural or artificial draught through the cooling tower.

Neglecting the factor of evaporation, as is widely practised, can result in grave error, as is seen from a series of carefully conducted tests on various types of available cooling sections. These sections were equipped with means for measuring accurately the water on and off the surfaces, and for obtaining the resulting temperature changes. Heated water was circulated through the tubes of these coolers at definite rates, and from the change in temperature from inlet to outlet, the heat removed was determined for each case. The difference between the heat lost by the water within the tubes and the sensible heat gained by the cooling water represents the amount dissipated by the evaporation of a portion of the cooling water. In all, forty-five different tests were made.

While the results were not conclusive in all respects, they were partly so in many respects, however, and indicated that the direction and velocity of the wind, together with the relative humidity, had no uniform influence on the amount of heat removed in the evaporation of a portion of the cooling water. These factors were therefore discarded in the final correlation. The governing factors of the problem were shown to be the cooling-water concentration rate on the cooling surface, the logarithmic mean temperature of the cooling water striking and leaving the cooling surface, and the design or arrangement of the cooling surface itself.

Charts are developed, and their use is explained and illustrated by numerical calculations based on the conventional concepts of calculating the coefficients of film resistances to the flow of heat. The charts are for dimensionally similar systems.

A. H. N.

310.* High-Tensile Steel for Refinery Service. W. L. Archer. *Refiner*, October 1940, **19** (10), 383–386.—By far the greatest majority of pressure vessels have been constructed from low-carbon steel made to A.S.T.M. A.70 specification. This material contains little carbon (never more than 0·30%) and a moderate amount of manganese (decidedly less than the 0·80% maximum that is allowed).

On the other hand, the high-tensile-strength steel contains more carbon, more manganese, and, in addition, silicon. The upper limits for these elements now become for carbon, 0·35%; for manganese, 0·90%; and for silicon, 0·30%. Thus an increase of about 1% in minor elements raises the strength of the steel from the minimum of 55,000 lb./sq. in. common to ordinary steel to a minimum of either 65,000 or 70,000 lb./sq. in. for the high-strength steel.

The principal reason for using high-tensile steel is to save money. The balance of higher manufacturing costs against lower fabricating and freight costs, due to smaller sizes and weights necessary as compared with ordinary low carbon steels, appears to be in favour of the high-tensile steel.

High-tensile-strength steel will not prove economical for all applications. For instance, joints more than 1 in. in thickness must be radiographed according to the code. Conceivably the cost of radiographing might be such as to prohibit the use of the high-strength material. Instances of that nature have been found.

High-tensile steel corrodes at the same rate as ordinary steel. That means two things: expensive material must be sacrificed for corrosion allowance; and the factor of safety is reduced by corrosion more rapidly than is the case with low-carbon steel of lesser strength. A. H. N.

311.* Propane Treating with Caustic Solution. Anon. *Refiner*, October 1940, **19** (10), 387–388.—The treatment consists of contacting the vapours, which make up the feed to the deethanizer, with sodium hydroxide solution, in two steps. The object of the treating is to remove enough hydrogen sulphide, so that the finished propane will meet the specification when tested for hydrogen sulphide by means of the lead acetate method as described in Bureau of Standards Technical Paper No. 41.

Most of the work is done in the treating section in the top of the depropanizer tower. The vapours leaving the fractionating portion of the tower pass up through a chimney into the treating section. This section is 15 ft. 9 in. high, with a diameter of 4 ft. 6 in. There is a bottom section 6 ft. 6 in. high, in which the used caustic accumulates. Above this are four bubble trays, spaced 1 ft. 6 in. apart. The entering caustic flows on to the top tray, down over the remaining three trays, and is released from bottom by a liquid level controller.

Details are given for capacity and requirements. A. H. N.

312.* Layout and Application of Stainless Strip Lining to Refinery Vessels. W. W. McClow. *Refiner*, December 1940, **19** (12), 451–455.—The discussion is confined to the mechanics involved in laying out and applying a stainless lining to an actual vessel. In the particular case under consideration a 12-gauge lining with an analysis of 12–14% chromium, 0·08% max. carbon, was applied in the form of 4-in. strips to a fractionating tower having an inside diameter of 8 ft. 6 in. All surfaces to be lined were thoroughly cleaned and sandblasted before proceeding with the lining application.

The tower-head under discussion is described as a semi-ellipsoidal surface generated by a semi-ellipse rotating about its minor axis and having a ratio between its major and minor axes of 2–1.

Although the detailed calculations and operations described deal with a head having the shape of an oblate spheroid, it is noted that the same line of reasoning and lay-out methods would be equally applicable to prolate spheroids as well as the sphere itself, although there is no evidence available to indicate that the former is used to any extent for refinery vessels. A prolate spheroid is distinguished from an oblate spheroid by the fact that it is generated by an ellipse rotating about its major axis instead of its minor axis. The sphere is a special case of the spheroid in which the major and minor axes are equal in length.

The paper is detailed in style, and in conclusion it is stated that success or failure of the lining applications described depended largely on the thoroughness and degree of accuracy carried out in preliminary analyses, as well as in the actual tower lay-out and application of lining material. No amount of preliminary work could have compensated for inaccurate or careless workmanship in the tower, however, and for that reason irregular welds or discrepancies of more than $\frac{1}{4}$ in. in fitting were not permitted. As a result of careful planning and accurate application, the installation met every expectation as to economy and quality of workmanship. A. H. N.

313.* Practical Water Conditioning for Industrial Purposes. H. Bottomley, *Refiner*, December 1940, **19** (12), 465–470.—Water conditioned for boiler-feed purposes must have several distinct properties; freedom from oxygen that would oxidize the metal of the boilers and lines, freedom from encrusting salts that would form scale in boilers and feed-lines, freedom from corrosive salts, freedom from suspended solids that would settle in boilers and lines, probably causing stoppage or tube failures, and maintenance of excess alkalinity to care for traces of residual encrusting salts that enter the evaporative equipment.

Waters derived from cisterns and some surface supplies are sufficiently soft to be used directly in boilers without chemical treatment. However, they are often turbid or contain large quantities of dissolved oxygen. To eliminate the former the water must be either settled or filtered, sometimes both, depending on the density of the solids and their rate of settling.

De-aeration is usually accompanied at elevated temperatures in conjunction with an alkaline treatment such as lime, lime–soda, or caustic soda. De-aeration may also be accomplished in the cold or hot condition by means of the addition of some chemical capable of combining with the oxygen to form a stable compound that has no detrimental effect on the steam-generating system.

Zeolite treatment and the base exchange involved are described. From a detailed discussion it appears that for each pressure range used in steam generation there is a ratio between the caustic alkalinity and the sodium sulphate content that will protect the boiler-plates and nozzles from "caustic embrittlement." In many normal waters the balance between carbonate and non-carbonate hardness produces a caustic–sulphate ratio that is well within the limits recommended, but in others it is necessary at times to add non-encrusting sulphate salts or sulphuric acid in closely controlled quantities.

Softening with lime is next discussed followed by lime–soda treatment. Reactions and costs involved are studied. The softening reactions with lime and/or soda ash will proceed in the cold, but are very much accelerated if the water is heated, the increase in speed being about doubled for each 10 degree rise in temperature. Along with hastened reactions is the increased speed of settling of the precipitated sludge due to the reduced viscosity of the water at the higher temperatures. Whether to treat in the cold- or hot-phase should be governed by the use to which the treated water is put.

A water high in temporary hardness—*i.e.*, carbonate hardness—may be more cheaply treated with lime and soda ash than with zeolite, whereas, conversely, if a water is composed largely of magnesium and calcium sulphate and chloride hardness, the zeolite treatment will be more favourable.

A mixture of caustic soda, soda ash, or sodium phosphate and tannin are very effective as an internal treatment. The mixture should be made up and preferably fed continuously at the point where the feed-water line enters the boiler. The concentration of the boiler-water should be closely watched, and not allowed to get to the point where foaming and priming will take place. Alkalinities of the order of those carried in boilers fed with lime–soda ash softened water are acceptable, and if the A.S.M.E. caustic–sulphate ratio is watched and held within proper limits, no particularly difficult situation should arise by internally treating waters up to 25 gm./gal. total hardness. Continuous blow-down is preferable to intermittent blow-down when internally treating, as this does not allow the sludge to settle in the drums. However, intermittent blow-downs should also be employed periodically to rid the bottom drum of any localized accumulation of sludge. A. H. N.

314.* Steels for Low-Temperature Service. W. L. Archer. *Refiner*, December 1940, **19** (12), 471–473.—Ordinarily when tensile strength and yield point of steels increase both elongation and reduction of area values (the ductility indices) decrease. As the temperature of steels is lowered, both the tensile strength and the yield point become greater. But the lowering of the ductility figures is less than would be expected, and all the physical properties of steel are satisfactory as temperatures become lower, with one outstanding exception: the impact strength. At low temperatures steel is embrittled.

For temperatures down to — 100° F. it is possible to use unalloyed steels that have been made with due attention to their ultimate service conditions. For tem-

peratures of − 50° F. to − 150° F. the best solution appears to be the use of steel alloyed with nickel. The overlapping of temperatures is not an accident. Nickel steel is so outstanding in this temperature range that a slight extra cost may be warranted. And, finally, for temperatures below − 150° F. the use of an austenitic stainless steel, such as 18–8, may best suit the conditions.

Methods of measuring embrittlement by means of Charpy impact specimens are detailed for specimens with keyhole and V-notches.

Many steels, particularly those greater than 2 in. in thickness, are normalized. The normalizing heat treatment of heating the steel to a point above its critical temperature and cooling in still air refines the grain. In sections lighter than 2 in. the working that takes place during the rolling operation is believed to refine the grain sufficiently. Steels with fine grain possess greater impact strength than those with coarse grains.

Welding of nickel and molybdenum steels concludes the paper. A. H. N.

315.* Propeller Pumps for Circulation of Molten Salt. A. J. Stepanoff. *Refiner*, December 1940, **19** (12), 474–476.—One of the serious problems encountered in pumping hot salt is the question of cavitation. Although in a certain process the hot salt is pumped from atmospheric pressure and submergence of several feet above the propeller is available, the behaviour of the pump as to cavitation is entirely different from that when pumping water under similar suction conditions. The difference comes, not from the high temperatures of the hot salt (as long as it is not boiling), but from the high specific gravity. The difference is well illustrated by a problem which shows that in the case cited a submergence of 6 ft. of salt is equivalent to a suction lift of 8·3 ft. for water-pumps in calculating the cavitation factor.

Another problem arises when pumping hot salt resulting from the effect of specific gravity of hot salt on the hydraulic axial thrust of the pump. For an axial-flow propeller pump the axial thrust is approximately equal to the suction opening of the pump in square inches multiplied by the pump total head in lb./sq. in. Evidently the hydraulic axial thrust will be greater in the ratio of specific gravity when pumping hot salt. This is usually taken up by the motor thrust bearing, which requires special design.

The matter is more complicated by the fact that the pumps have to work against shut-off head at times when the discharge valve is closed, and the head under these conditions may be more than twice the normal operating head. The method of avoiding troubles due to this cause is illustrated diagrammatically by two alternative designs—one with the stresses nullified and the second with the stresses on the motor supports acting in full force. A. H. N.

316.* Phosphorus-Pentoxide as a Refining Agent. H. Heinemann. *Refiner*, December 1940, **19** (12), 477–478.—Phosphorus-pentoxide can be used under well-defined favourable conditions as a comparatively selective polymerization catalyst for diolefines and acetylenes. This means that under such conditions, and due to the tendency of diolefines as compared with mono-olefines to polymerize, these compounds will be converted, while mono-olefines are not affected. Since diolefines constitute most of the gum-forming substances, selective treatment with P_2O_5 provides a method to remove potential gum from gasolines, polymerizing the diolefines to high-boiling substances which are separated from the gasoline by distillation, while not affecting the mono-olefines in the gasoline, and thus preventing losses which might be caused by the polymerization of olefines boiling in the gasoline range.

One difficulty encountered in contacting gasoline or gasoline vapours with P_2O_5 is that the phosphorus-pentoxide conglomerates and forms lumps which reduce the active surface considerably.

It has been found that, when phosphorus-pentoxide is suspended in a hot oil by injecting it in small quantities into the circulating liquid while the suspension is kept hot, it will not conglomerate, even if the fresh suspension is contacted with gasoline.

The procedure as practised in a pilot plant is fully described, and it appears that the process is competitive with clay treatment, due to the smaller losses in yield and no loss in octane rating. A. H. N.

317.* Refining Pennsylvania Lubricating Oils by Phenol Extraction. D. W. Kenny and W. B. McCluer. *Refiner*, January 1941, **20** (1), 1–4.—An extensive survey of solvent extraction processes as applicable to Bradford crudes was made in 1939. Included in this research programme was the construction of a small-scale extraction pilot plant, which was operated on several different stocks under a variety of different conditions. Block and fleet engine tests were run on solvent-treated oils produced at the pilot plant, and a critical examination of all the factors involved led to the installation of a commercial phenol extraction plant. Selection of this process was based on a detailed consideration of investment costs, operating costs, quality improvement, ease and flexibility of operation, and adaptability of the process to present and future refining requirements.

The solvent, in addition to its selective properties, should be economically available, chemically stable under conditions of storage and use, and capable of full recovery. Phenol satisfies all these requirements, and, in addition, its use does not require expensive corrosion-resistant materials of construction.

A description of the plant and its operations is given. The plant was designed to handle 1500 brl. of oil and 1400 brl. of phenol/stream day. The actual operating capacity of the plant depends therefore on the type of stock handled, the solvent dosage, the selectivity of treat, and the amount of extract removed. On the basis of 10% extract removal, the nominal design capacity was 1250 brl. for dewaxed neutrals, 1050 brl. for 150 viscosity residual stock, and 500 brl. for residual stock having a viscosity of 2000 Saybolt Universal seconds at 210° F. The treating tower contains nineteen packed trays which serve to collect and redisperse the discontinuous phase, thus improving distribution and contacting efficiency. Anhydrous phenol (or, if desired, phenol containing a small but controlled amount of water) enters the top of the treating tower, and phenolic water (containing about 11% phenol) is introduced in controlled amount at the base. The purpose of the phenolic water is to provide reflux in the treating tower.

Details of operating conditions and data on the finished stocks are included.

A. H. N.

318.* Regardless of Charging Stock, only Two Liquid Products Recovered. Anon. *Refiner*, January 1941, **20** (1), 5–7.—The charge to this cracking plant varies from day to day, and frequently the type of the charging stock is changed twice daily. If fresh crude is in the storage tanks, that may be cracked alone or blended with a heavy topped crude obtained from other refineries. Again, the material on hand may consist of slops, topped crude, heavy fuel, and crude oil, all of which, after blending, may be charged directly to the main column in the usual manner. It appears to matter little what stock is available, as the plant operating conditions can be changed without loss of stream time or a reduction in throughput, and the plant continues to produce two products without any appreciable change in the quality of either.

One of the units in this plant that is different from most cracking plants is the reaction chamber. Instead of being designed to operate at the conventional pressure of 275 lb., this chamber is designed for an operating pressure of 600 lb. if required, and it is frequently run at a pressure as high as 550 lb., particularly when the charging stock consists of kerosine distillate. The chamber is 4 ft. 6 in. in diameter and 40 ft. high, with $1\frac{7}{16}$-in. walls, fusion welded and stress relieved, and lined throughout with an 11–16 chrome steel shell.

The operation of the plant and details of the recycle ratios, the phosphoric-acid catalytic columns and test results of products from crude and kerosine charges are included.

A. H. N.

319.* Unit Costs for Compressed Air and Steam. J. R. Darnell. *Refiner*, January 1941, **20** (1), 14–16.—An efficient inside mixing type of fuel-oil burner requires from 0·10 to 0·30 lb. of steam/lb. of oil for atomization. In terms of steam output, the steam for atomization will vary from 0·7% to about 2%. If air were used, even though heated, it would require a greater amount than steam, and in either case the cost would be prohibitive. An example worked out numerically illustrates this statement.

Normally the fuel cost is the largest item of steam cost; averaging from 75% to

80% of the total. Water treatment and pumping costs may vary from 3% to 6%, operating labour will be about 7% to 8%, maintenance from 3% to 6%, and fixed charges about 3%.

If the feed-water is not heated by waste heat, the fuel cost will increase, and if the water is treated, the cost for this operation will be higher and maintenance lower than where hard water is used. If the water is not treated, the increased maintenance cost will probably be much more than the cost of treating.

Fuel cost, of course, depends on the kind, equipment for firing, and the resultant efficiency. Where coal is used, the cost for this item starting with the price f.o.b. mine increases with freight and handling charges.

Discussions of power charges for pulverization and blowing when powdered coal is used are made. Fuel-oil and gas-firing systems are contrasted, and maintenance and operating labour costs are studied.

Warnings against allowing leak losses over long periods are stressed by worked-out examples. A. H. N.

320.* **The Refiner's Alloy.** W. L. Archer. *Refiner*, January 1941, **20** (1), 19.—Three problems had to be solved simultaneously in designing an alloy for the refiner's needs; resistance to corrosion, resistance to scaling or oxidation, and good creep strength at elevated temperatures. 5%-chromium steel proved to be the answer after a series of exhaustive tests disclosed the relationship between chromium content and the rate of corrosion. Properties and difficulties encountered in the use of such steels are discussed.

Three welding processes are available for the welding of the 5%-chromium steels. These are the oxy-acetylene process, the atomic hydrogen process, and the metallic arc process. The gas-welding method requires very close control when it is used, for a reducing or carburizing flame may add carbon to the deposit, thus aggravating an already bad air-hardening propensity. On the other hand, an oxidizing flame leads to the formation of chromium oxide and reduces the chromium content of the weld.

The second method, the atomic hydrogen process, is subject to the same limitations that are encountered in its use for mild-steel welding applications. In general, sheet metal is best welded by the atomic hydrogen process, leaving the thicker metals for the metallic arc.

The third, and most commonly used, method is the metallic arc. Here the selection of the proper electrode is of the utmost importance. Not only must the deposited metal possess the desired chemical and physical properties, but also the electrode must be capable of easy manipulation. Details are given.

The improvements conferred on 5%-chromium steel by the addition of columbium are discussed, the most important being the reduction of air-hardening tendencies during welding.

Application of the 5%-chromium steel is studied, the chief being in lining towers. A. H. N.

321.* **Process for the Conversion of Pennsylvania Bright Stocks to Neutrals.** C. R. Wagner. *Refiner*, January 1941, **20** (1), 24–25.—Economics necessitate the process. In the process 15 pour bright stock is charged to a shell-still. This is blended with 10% light oil such as kerosine. An alternative is to charge bright stock solution. Either procedure is satisfactory, the choice depending largely on whether it is desired to convert bright stock from storage or current production. The advantage of processing solution lies in the elimination of blending with light oil and the heat saving due to heating the bright stock only once. The still is brought up to temperature rapidly in the case of processing bright stock, and conventionally when processing solution until the solution is denuded. Liberal steam is introduced. The overhead stream is cut first to naphtha storage, then gas oil and, when the stream viscosity reaches 35–40, at 100, it is cut to 180 stock storage. At this point the still temperature is approximately 525–550° F. The supply of steam is then cut back sharply and rapid firing is maintained. The still temperature quickly reaches approximately 620° F., and the viscosity of the overhead is 90–100 at 100. Steam and firing are then controlled to maintain the viscosity of the stream between 90 and 120 at 100° F. The operation is continued until about 93–96% of the original bright

stock charge is taken overhead. The still temperature at this time has risen to approximately 700–720° F. The average cycle time from charge to charge will run about 60 hr. The bottoms can be segregated until enough is accumulated, and then mixed with a light oil and re-processed in a similar manner to the original bright-stock conversion operation for the production of additional 180 stock, or it can be put to fuel oil.

The yield and quality of products are illustrated by typical data. The overall operating cost/gal. of 180 neutral from bright stock is $0·0325. A. H. N.

Chemistry and Physics of Petroleum.

322.* Studies on the Separation of Paraffin Waxes. Part III. The Sweating of Oil-Free Waxes. M. F. Sawyer, T. G. Hunter, and A. W. Nash. *J. Inst. Petrol.*, 1941, **27** (207), 1–14.—Experiments and results are reported on laboratory sweating of paraffin waxes under conditions which allowed constant rates of sweating to operate for the duration of experiments. Rates of 3%/hr. or less are suggested to be used as bases of computations for sweating efficiencies. A. H. N.

323.* Improvement of Mixed Cresols for Inhibitor Purposes: The Use of Mesitol As a Gum Inhibitor. T. Kennedy. *J. Inst. Petrol.*, 1941, **27** (207), 15–18.—Mesitol is found to be more potent as an inhibitor than *o*-cresol. Methods of synthesis of mesitol from cresols and formaldehyde are reported. A. H. N.

324.* Effect of Alkyl Substitution on the Efficiency of Phenols as Inhibitors of Gum Formation in Petroleum Products. T. Kennedy. *J. Inst. Petrol.*, 1941, **27** (207), 19–30.—Alkyl substituted phenols are studied in connection with their inhibiting effects on gum formation by recording the induction periods of the treated Iranian cracked spirits and comparative efficiencies are reported. A. H. N.

325.* Elements of Vaporization and Condensation. Part IX. R. L. Huntington. *Refiner*, October 1940, **19** (10), 389–392.—The number of theoretical trays required for a given separation of a binary mixture into relatively pure components is controlled largely by the pressure under which the fractionating column operates—*i.e.*, the higher the pressure the greater the number of trays required, because of the lowering of the relative volatility of the respective components. Above the retrograde or inversion pressure range, however (from 700–1200 lb./sq. in. for a number of hydrocarbon mixtures), there is apt to be a reversal in this trend which might cause a reduction in the number of trays for further pressure increases.

There are five types of binary mixtures in general which call for fractionation as a practical means of effecting certain separations. Pressure-composition and temperature-composition diagrams serve as tools in presenting the underlying theory or ground work for the fractionation of such mixtures. The y versus x curve which shows the mol. fraction of the more volatile constituent in the vapour in its relationship to the mol. fraction of the same constituent in the liquid has proved to be the most useful method in attacking the problem of fractionation from a practical point of view.

Mixtures illustrating the five types are such as butane–pentane for ideal solutions, ethyl alcohol–water for minimum boiling points mixtures, hydrochloric acid–water for maximum boiling points mixtures, sugars for stereo-isomers impossible to fractionate by distillation and phenol–water for partly miscible mixtures.

A brief study is made of the effects of varying the reflux ratio from a minimum upwards on the number of theoretical planes. Graphical methods (McCabe–Thiele diagrams) are used. A. H. N.

326.* Plant Exchanger Transfer Rates. W. L. Nelson. *Oil Gas J.*, 4.7.40, **39** (8), 32.—The magnitude of the loss in heat-transfer rates due to dirt, corrosion, etc., appears to be under-estimated by some authorities. A calculation of fouling factors on a number of exchangers yielded results 200–400% higher than those published in

the literature on the subject. Resistance to heat flow may be a more significant factor than some variables, such as even viscosity or velocity. H. G.

327.* **Gas-Liquid Equilibrium Constants.** H. M. Lavender, B. H. Sage, and W. N. Lacey. *Oil Gas J.*, 11.7.40, **39** (9), 48–49.—The article describes the method adopted for determining the composition of the dew-point gas in the methane–decane system at 100°, 160°, and 220° F., and at pressures from 200 to 2000 lb./sq. in. Data relating to the co-existing phases are published. H. G.

328.* **Mixed Catalysts Promise Optimum in Hydrogenation of Benzene.** V. N. Ipatieff. *Nat. Petrol. News*, 7.8.40, **32** (32), R. 280, R. 282.—The investigation of the effect of the mixing of catalysts on catalytic efficiency has shown that, in many cases, extremely small quantities of a second body can have profound effects on the activity of the major constituent of the mixture. Quantities of lead too small to be detected spectroscopically can alter the activity of a Cu–Ni–Cr catalyst in the hydrogenation of benzene. Hence spectroscopic purity is not a guarantee of catalytic purity. If the addition of a second catalyst produces an increase in catalytic activity there is an optimum mixture which is called the eucoactive mixture. There is a *eucoactive* mixture of Cu and Cr and of Cu/Cr–Ni for the hydrogenation of benzene. It would appear that a more complete knowledge of the chemical properties and composition of catalysts must preface a more complete understanding of the mechanism of catalysis. H. G.

329.* **Electrical Pyrolysis of Hydrocarbons.** R. Fussteig. *Petrol. Engr*, February 1940, **11** (5), 58.—Treatment by silent electric discharge or voltolization may be used to convert low-grade oils into high-quality lubricants, or to effect "cracking" to yield gasoline. A discharge of quite different intensity is required for the two reactions.

In the production of lubricants the reaction taking place consists of the splitting up of C–H linkages to give unstable hydrocarbons which polymerize to yield oils of higher viscosity which have a high viscosity index and oiliness. The split up of the C–H linkage is considered to be similar to electric dissociation, the hydrocarbon yielding positive hydrogen ions and negative hydrocarbon ions. A number of the voltolization processes used for the production of high-grade lubricants are described. In one of these hydrogen of a high degree of purity suitable for the hydrogenation of fats is produced in addition to a high-quality voltoil.

In the production of gasoline the reaction taking place consists of the splitting up of C–C linkages to yield lower-molecular-weight hydrocarbons. This cracking reaction is attributed to "electronic bombardment." In the liquid-phase electrical heat plays a more important rôle in the cracking reaction than the silent discharge. In the vapour-phase, however, the ionization and electronic bombardment induced by the discharge produce a maximum yield of gasoline. The most important process of this type consists of subjecting hydrocarbon vapours at 400°/C. to silent electric discharges of high frequency. A proposed method for the destructive hydrogenation of liquid hydrocarbon and solid such as coal or bitumen, the former yielding gasoline and the latter benzol, is described. R. J. E.

330.* **Elements of Vaporization and Condensation. Part X.** R. L. Huntington. *Refiner*, January 1941, **20** (1), 26–29.—The calculation of the number of theoretical trays required for the processing of complex mixtures cannot be carried out rigorously by means of the McCabe–Thiele binary component diagram. Through the selection, however, of two key components in a complex mixture, a fair approximation can be made of the plate requirements for a fractionating tower by this simple two-component diagram. In this analysis the author has taken the fraction of a gasoline boiling in the kerosine range as the less volatile component of the binary mixture, and the gasoline fraction of the kerosine as the more volatile component. By applying this method to the performance of a 3 ft. × 90 ft. bubble-plate tower, it was found that the fractionation efficiency in the 10-plate gasoline–kerosine section was 90% of the theoretical.

In the case of a four-component mixture such as propane 25 mol.-%, *n*-butane

25 mol.-%, *n*-pentane 25 mol.-%, *n*-hexane 25 mol.-%, two key components such as normal butane and normal pentane might be selected if the propane and normal butane are to be taken off overhead, since the propane would have very little tendency to go to the bottom of the tower and vice versa for normal hexane.

An actual example worked out completely illustrates the complexity and tediousness of solving by normal methods. Reference is made to " short-cut " methods.

A. H. N.

331.* Equilibria in Reactions of Hydrocarbons. Part XII. Calculation of Equilibria in Isomerization of Butenes and Butanes. A. V. Frost. *Refiner*, January 1941, **20** (1), 30–33.—It has been shown that equilibria in hydrogenation of ethylene, propene, and butenes can be calculated from the free energies of formation of these hydrocarbons obtained from spectroscopical values, and that the results of these calculations are in good agreement with experimental data given by a number of authors. However, for cases of equilibria in reactions,

$$\textit{norm.}\ C_4H_8\ (\text{sum of isomers}) \longleftrightarrow \textit{iso}\text{-}C_4H_8$$
$$\text{and } \textit{norm.}\ C_4H_{10} \longleftrightarrow \textit{iso}\text{-}C_4H_{10},$$

taking place with branching of the carbon skeletons spectroscopic data show poor agreement with experimental results.

The causes of the deviations observed on comparing the data calculated from spectroscopical work and experimental findings are studied, and it is shown that a decrease of the heat of isomerization of *n*-butane to *iso*butane to $\Delta H_{298\cdot1} = -2270 \pm 200$ cals./mole makes it possible to prevent the discrepancy.

A. H. N.

Analysis and Testing.

332.* Evaluation of Steels for Cracking Tube Service by Stress-Rupture Tests. C. L. Clark and W. G. Hildorf. *Refiner*, December 1940, **19** (12), 456–464.—The test differs from short time tests in that it maintains the stress for long periods, from a few minutes to several thousand hours, but also differs from creep tests. The reasons for adopting the stress-rupture test are first detailed, and then the procedure is described. In the stress-rupture tests a series of specimens of each steel at each temperature are broken under constant stress with the stresses being so selected that fracture will result over time periods varying from a few minutes up to a maximum of several hundred or several thousand hours.

The results are discussed in detail, and the conclusions are that the stress-rupture test is very useful in the evaluation of steels for cracking tube service, for the following reasons :

It affords a more simple means of determining the load-carrying ability, and the rates of deformation in the prolonged tests are more comparable to those obtained during actual bulging or fracture of still tubes under over-heated, and thus over-stressed, conditions. Moreover, extrapolations to longer time periods are more justified than in most other types of tests because of the definite relationship which exists and because the values themselves are more fixed, not being as dependent on testing conditions.

It affords a convenient means for determining the influence of time, temperature, and stress on the surface and structural stability, as well as on the overall ductility up to fracture. The atmosphere can be readily varied so as to determine the influence of this factor.

It indicates the degree to which a given steel can be overheated during service and the length of time this overheated condition can be maintained.

It permits, on the basis of tests of 200–300 hr., a rapid classification of the load-carrying ability of a series of steels of the same general type.

It may serve as an acceptability test in indicating whether or not a given heat of steel possesses the desired degree of load-carrying ability.

The stress-rupture tests, in combination with other tests, will, therefore, assist in more completely establishing the high-temperature characteristics of a given steel.

A. H. N.

333.* Obtaining Accuracy in Orsat Analyses. J. Griswold and J. W. Morris. *Refiner*, January 1941, **20** (1), 10–13.—The paper describes essential details for the use of the equipment and preparation of reagents for the conventional Orsat apparatus, by which flue-gas analyses accurate to 0·1% may be consistently obtained. Certain precautions frequently overlooked may result in errors of several times this figure.

The special precautions found necessary for accurate determinations with this type of apparatus are: (1) The measuring burette should be frequently checked for drainage error, and be cleaned whenever necessary with acid–dichromate solution. (2) The burette, its capillary connection, and the manifold tubing should be calibrated, and the total volume of the sample taken for analysis should be corrected accordingly. (3) Whenever a volume measurement is to be made, the gas should be drawn into the burette slowly during a period of 30 sec. and followed by a 30-sec. wait for complete drainage. (4) The potassium pyrogallate reagent for oxygen absorption is dependable only when made up with saturated KOH solution. (5) The fact that acid cuprous chloride solution is very slow in rate of absorption must be allowed for, and it should be renewed after absorption of 8–10 c.c. of CO. It thus gives quantitative absorption without liberating HCl or CO.

The effects of barometric pressures (maximum in the case of analyses for small quantities of CO), of drainage errors in the burette, and of temperature variation on the volume readings to be taken are discussed. Analyses for oxygen, carbon dioxide, and monoxide are given in detail. A. H. N.

Motor Fuels.

334.* Production of Ketones and their Use as Fuels of High Octane Value. Ch. Berthelot. *Chem. et Ind.*, [November 1939], **42** (5), 779–786.—The progress recently made in the construction of aviation engines calls for the use of fuels having very high anti-knock values. The usual limits of 87/90 octane value reached up to recently appear to be insufficient for use in the motors used at present and those likely to be developed in the near future. Tests have shown that an increase in power of 30% and more can be attained by using fuels having an octane value of about 100.

The new ketone industry provides fuels having high anti-knock values (100 octane) and uses basic materials of an exclusively national source. This industry comprises four stages, which are as follows:

(1) Transformation by chemical reactions of such basic materials as cellulose in all its forms, and particularly waste (wood, sawdust, grapevine branches, rice waste, olive husks, etc.) into fermentable products.

(2) Selective fermentation of any sugars and starchy materials (plant molasses, damaged cereals, etc.) into a mixture of definite chemical compounds.

(3) The transformation of these compounds into motor fuels.

(4) The ketone industry is supplemented by the synthesis into high-octane-value fuels of such basic substances as acetylene, acetone, etc., the synthetic bodies having octane values of over 100.

The various materials thus obtained form excellent fuels, satisfying all the specifications for aviation fuels. They can be used as such or blended in all proportions with the widest variety of petroleum products to increase the anti-knock value, if necessary in conjunction with T.E.L. M. M. L.

Lubricants and Lubrication.

335.* Colour Density and Acid Vapour Indicate Oil Performance. W. F. Weiland. *Nat. Petrol. News*, 9.8.39, **31** (32), R. 334.—The visible changes in colour and the reduction in the temperature at which an oil produces acid vapours have been correlated with the oxidation tendencies and sludging and corrosion tendencies respectively. The colour density ratio or oxidation number is defined as the ratio of the lengths of equi-coloured columns of oil representing the oil before and after use. The acid vapour temperature is that at which the oil first produces vapours acid to

litmus when distilled under standard conditions. The results of the experiments described indicate that the acid vapour temperature falls as oxidation proceeds, and that there is a relation between visible oil breakdown and the a.v. temperature. Similarly colour density ratio/time curves appear to be related to the ability of the oil to withstand the effects of oxidation. H. G.

Special Products.

336.* Butyl Rubber—a New Hydrocarbon Product. R. M. Thomas, I. E. Lightbown, W. J. Sparks, P. K. Frolich, and E. V. Murphree. *Refiner*, October 1940, **19** (10), 359–369.—Studies conducted on polymers of the simple mono-olefine which have been in progress for ten years have led to some interesting conclusions. It was shown that high-molecular-weight linear polymers derived from simple olefins, such as the butylenes, possess a majority of the properties characteristic of rubber. Only the susceptibility to chemical action can definitely be attributed to the unsaturation of the natural rubber molecule. Physical properties which appear not to be intrinsically dependent on the carbon–double bond–carbon configuration are: tensile strength, elasticity, rebound, elastic memory, X-ray structure, mechanical orientation, electrical properties, and fractional solubility. It was, however, conclusively demonstrated that the saturated polymers are not capable of vulcanization in the conventional manner.

From these and other studies it is concluded that the chemical unsaturation, which is so important from the standpoint of permitting vulcanization to take place, is also the greatest weakness of the natural rubber molecule. The reason for this is that in the case of soft goods, which represent by far the major outlet for rubber, only a fraction of the available double bonds is utilized in the vulcanization with sulphur.

With these considerations an attempt to produce synthetic rubber with only a limited amount of unsaturation required for vulcanization, and no more, was made. "Butyl rubber" designates the result, which is a 100% petroleum hydrocarbon product with an unsaturation corresponding to between 1% and 2% of that found in natural rubber, as determined by iodine number, and with a molecular weight in the general range of 40,000–80,000 as determined by viscosity measurements on dilute solutions. Because of its freedom from impurities, in so far as these can be detected by ordinary chemical analysis, it is colourless and devoid of odour or taste. In appearance, it resembles natural crêpe rubber. Since it is an aliphatic hydrocarbon polymer, the density (0·91) approaches the minimum attainable for elastic materials of this type.

Because the original unsaturation is very small, and because even this low unsaturation is greatly reduced (and may even be entirely eliminated) during the curing operation, vulcanized butyl rubber is extremely resistant to chemical attack. This is true because it has become, after vulcanization, not only a non-thermoplastic, strong elastic material, but also an essential chemically saturated product as well. This means that, while from a physical standpoint vulcanized butyl rubber resembles soft vulcanized natural rubber, chemically it may be considered more similar to ebonite. It is extremely resistant to acids (even concentrated sulphuric or nitric), to oxidation, to ozone, and to other deteriorating influences. Like natural rubber, butyl rubber is not resistant to aliphatic hydrocarbons, but it does show a surprising resistance to benzene, ethylene dichloride, and oxygenated solvents.

Interesting curves and photographs illustrate in detail the properties summarized here. The properties studied are resistance to ageing and chemical action, tensile strength and stress-strain relationship, impact cutting resistance, loading and reinforcing characteristics, elasticity and hysteresis loss, resistance to flexing, to abrasion and to tear, lack of rebound at ordinary temperatures, resistance to water absorption, to certain solvents, and to gas permeability and electrical potential. A. H. N.

Economics and Statistics.

337.* World Supply and Demand at New Peak. H. S. Norman. *Oil Gas J.*, 26.12.40, **39** (33), 62.—World production for 1940 is estimated at 2,150,679,040 brl.—about

4% above the 1939 figure. A table gives the production by countries for 1929 and 1940, estimates being made for countries where military considerations preclude obtaining the actual figures, and the exports by U.S.A. of various products for the first war year are compared with those for the previous year. America's total exports are down by 28·3%.

In 1940 North America provided 65% of the world's total oil. Canada produced 8,549,760 brl. Central and South American countries had their oil production severely affected by the war, Venezuela being one of the worst sufferers. Bolivia and Ecuador showed little change, but Peru continued to decline. Argentina's output rose by 10% to 20,476,100 brl., and Colombia showed a substantial rise to 26,864,400 brl. Trinidad's production is estimated at 20,300,000 brl.

Rumania's production fell considerably. Germany, through her own production and that acquired in Austria, France, Poland, Hungary, and Rumania, probably obtained 50,830,000 brl. of crude in 1940. The U.S.S.R. production increased by 4% to 225,000,000 brl., but was 28,000,000 brl. short of the planned 1940 output. Marine development off the Apsheron peninsula was the high light, and the chief source of new production was the Sub-Kirmak series at about 6700 ft.

The Iraq production probably fell by 5,000,000 brl. Iran's output was little changed, and the same was true for Bahrein and Saudi Arabia. Egypt's oil production rose by 50% to 6,655,730 brl. The Dutch East Indies output was fairly stable.

Tables summarize Venezuela's production in the first nine months of 1939 and 1940 by fields, and give the capacities of the various countries for refining. The amounts of oil normally transported through the Mediterranean are noted.

G. D. H.

338.* World Production of Petroleum Substitutes. V. R. Garfias and R. V. Whetsel. *Petrol. Tech.*, January 1941, A.I.M.M.E. Tech. Pub. No. 1274, 1–5.—In 1939 the world's production of petroleum substitutes, of which about 97% are direct substitutes for motor fuels, is tentatively estimated at 108,000,000 brl. With a few exceptions these figures of production also represent actual figures of consumption. U.S.A. gave 53% of the total, and that was mainly natural gasoline. Germany, largely due to improved methods of manufacturing motor fuels from coal, produced more than 20,000,000 brl. of substitutes.

The source materials and resulting substitutes are tabulated, and the gross heat equivalents of some of the substitutes in terms of barrels of gasoline are listed.

From natural gas liquid hydrocarbons are obtained, and also liquified propane and butane. Methane from wells is used as motor fuel in Italy. Gasoline and benzol are the main petroleum substitutes obtained from coal, but kerosine, diesel, fuel oils, and some lubricants are also produced. The main methods are high- and low-temperature carbonization and hydrogenation. The last process is claimed to be the most efficient. In 1939 28,730,000 brl. of petroleum substitutes were obtained from coal, 60% being made in Germany. From oil shale 2,490,000 brl. of petroleum substitutes were made, 1,300,000 brl. in Estonia. 7,320,000 brl. of motor-fuel alcohol were manufactured in 1939, 2,400,000 brl. being produced in Japan. The production of different fuels by various countries is listed for 1938 and 1939. G. D. H.

BOOK REVIEW

Elements of the Petroleum Industry. Edited by E. De Golyer. Pp. 520. The American Institute of Mining and Metallurgical Engineers. New York. 1940. (Price to non-members, $5; to A.I.M.E. members, $2.50.)

This book, which is sponsored by the Seeley W. Mudd Memorial Fund, carries a foreword by the Secretary of the A.I.M.E. which states that it is not designed primarily for those actively engaged in the petroleum industry, but more for the engineer, or even the "non-engineer," who is possessed of an intelligent curiosity regarding the "hows and whys" of the industry.

It is a descriptive book, or perhaps it should be more truly defined as a collection of articles dealing with the various phases of the exploration, exploitation, transport, refining, and marketing of petroleum and its products, contributed by a number of writers whose names are well known in the petroleum industry of the United States.

As is very often the case where a series of articles dealing with various aspects of one subject are bound together, there is a lack of balance throughout the publication and a certain amount of overlapping which, the reviewer knows only too well from experience as a general editor, is unavoidable in a book of this kind. Also some of the subjects are so subdivided that the authors of the shorter articles have not had an opportunity of treating their subject in as much detail as they obviously would wish.

The physical and chemical properties of petroleum and its products is a most difficult subject to present in a simple manner, particularly in a few pages, yet the reader is able to form some idea of the molecular structure of hydrocarbons both before and after thermal treatment and also to appreciate the disadvantages and advantages, respectively, of paraffinicity in gasolines and diesel fuels.

A description of oil and gas seepages, and other indications of the occurrence of oil and gas, as well as the geological conditions for the existence of oil-pools of economic value, then follows. The significance of oil origin, source-beds, and their relationship to oil-yielding beds, makes interesting reading; oil and gas reservoirs are also classified according to the method of closure of the strata. This section is really economic geology, and, considering the complexity of the subject, is clearly explained; nevertheless one feels that it is rather strong meat for the reader who is not versed in stratigraphy. It should, however, inspire those interested to pursue the subject further, and for this purpose the author gives a good bibliography on the subject comprising 33 references.

The chapter dealing with geophysical exploration is well written, and apart from the various methods of exploration and their use in locating subsurface structure, as well as electrical logging, the reader will be interested in the method of determining the hydrocarbon gas and liquid content of the soil, as first carried out by Russian investigators, as well as the method of soil analysis along the edges of known oilfields in the U.S.A., whereby lines of equal hydrocarbon content may be drawn so as to denote the confines of the field.

Three short chapters then deal with the acquisition of oil rights, land leasing, and royalties, more particularly relating to the U.S.A. Readers in this country will gain some amusement from a hypothetical conversation between a scout and his employer, in which the former—"Bill"—manages to "beat" the scouts of all the major companies, who have been watching a wildcat well which has come into production, to the only telephone in the town. This story introduces quite a Wild West atmosphere.

So far, just over one-fifth of the volume has been covered, which brings us to the next subject: oil-well drilling machinery and practice, two chapters occupying 135 pages, which is the real meat of the publication.

All kinds of drilling equipment are explained, with most excellent illustrations: drilling fluids, their densities and viscosities, the types of muds for different forma-

tions, data regarding well costs, including costs of preparation and completion as well as general costing; time costing and statistical records are also dealt with clearly. This is followed by a description of well surveying and its technique for determining angles of deviation and the azimuth of such angles at given points. The purpose and technique of directional drilling are explained and drift angles as high as 62° are recorded.

A very clear description of cable-tool and rotary-coring practice, as well as side-wall sampling and methods for determining porosity, permeability, and saturation of such samples, are given, together with diagrams of the laboratory apparatus used. Oil-well cementing, packing, and shooting, as well as acidization and gun-perforating, continue to hold the interest of the reader, and finally various methods of completing wells, after the producing formation has been reached, by no means exhausts the subjects dealt with. The chapter on "Drilling" represents 90 pages of well-written and interesting material, and includes a bibliography of 167 references: the author of this article acknowledges the help of ten collaborators.

Three short chapters are now given over to "Production Practice," "Conservation," and "Secondary Methods for Increasing Oil Recovery," wherein the function of gas in regard to fluid flow in an oil reservoir and its effect on viscosity and surface tension of the oil underground, as well as the Jamin effect of gas bubbles, are but a few of the subjects discussed. Artificial water-flooding and gas-repressuring, and the selection of intake wells are others, and a brief reference is made to the Ranney process of mining petroleum.

A description of oil pipe-line transportation follows, but the authors of "Marine Transportation," after pointing out that the lack of literature on this subject does not mean that this element of the oil industry is of minor importance, dismiss the subject in just over 3000 words.

The chapter on "Refining," by an author and five collaborators, is rather disappointing, largely due to the fact that the space given to it (49 pages) is much too limited. Its object, so it is stated, is to tell the story of the broader activities of the art of refining in such a way that geologists, physicists, engineers, and drillers can visualize how crude oil is converted to usable forms, but the descriptions of modern distillation equipment, heat exchangers, and bubble-tower fractionation are so sketchy that it is difficult to believe that the technical men listed above would find anything novel in this reading. No attempt is made to describe even simple principles.

Thermal cracking, hydrogenation-cracking, both for the purpose of producing gasoline and upgrading lubricants, as well as catalytic cracking by the Houdry method, and a newer method involving the mixing of the catalyst, in a finely divided form, with the vapours, are explained, in addition to the thermal and catalytic polymerization of C_3 and C_4 fractions and the physical characteristics of the polymer gasolines resulting. Thermal and catalytic alkylation, in view of its looming importance, is dealt with all too briefly, treating is dismissed in 30 lines, about double this space is given to blending, and the same to knock rating. Solvent treatment of lubricants, extreme-pressure lubricants, pour-point depressants, oxidation inhibitors, filter pressing, sweating, cold settling, and solvent wax separation, as well as the use of refinery gases as a source of chemical intermediates, are among the many subjects included in this comparatively short chapter.

The two chapters on "Marketing and the Economics of Price Stabilization," and "General and Cost Accounting," are of course related to American practice. The natural-gas industry is also described, but gasoline-extraction plants are dismissed in a few lines.

Those who are interested in the economics and policy of the American petroleum industry will find much to interest them in Chapter XX. Whilst it stresses the importance of operating fields under unit control and the advantages of prorationing and its resultant conservation of crude oil, it nevertheless points out that the well, rather than the oil reserve, having been accepted as the ultimate unit for allocation, has created artificial incentives for drilling more wells than are necessary to extract the oil required, and also for drilling in advance of economic requirements.

Another interesting point brought out by the author of this chapter, whose name is known to everyone in the petroleum world, is that, as oil can be produced cheaper in Venezuela (the largest source of U.S. imports of crude) than in U.S.A., because

of unit operation, some form of protective tariff has been found necessary to restrict the volume of imports to a fair ratio to domestic production.

The final chapter is a bibliography comprising an introduction to the literature of Oil and Gas, 84 publications, as well as various journals, compiled by the editor, who has been assisted throughout the book by an editorial advisory board of six names, of whom one is a contributor.

To those about to enter the petroleum industry, or to students about to take a course in petroleum technology, this book should prove of absorbing interest, and those unconnected with the petroleum industry who may wish to know something about it will find it very informative. The diagrams and illustrations are excellent, and some of the chapters have really good bibliographies.

A. W. NASH.

BOOK RECEIVED.

Methane—Its Production and Utilization. By J. P. Lawrie. Pp. 66. Chapman and Hall, Ltd., London. 1940. Price 6*s*.

This book represents a collection of available data relating to methane and its utilization as a fuel in internal-combustion engines. The author points out that large quantities of comparatively pure methane from mine "blowers," natural gas, and other sources are now going to waste in this country, and could in his opinion be easily made available for motor traction at an economic price, given the necessary compressing and storage plant. The author deals with the problems of compression, liquefaction, and the provision of suitable containers. The chief merit of the book is in its stimulation of interest in the subject rather than in the actual technical matter presented.

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Geology and Development.

339.* Hawkins Field Rated Largest Reserve Added in Year. B. Mills. *Oil Wkly*, 3.2.41, **100** (9), 12.—The Hawkins producing area appears to cover 7500–10,000 acres, with 25–200 ft. of oil-sand in the Woodbine. Its reserve is estimated at 300–600 million brl. The structure is an elongated anticline with closure of about 450 ft. The maximum thickness of Woodbine sand is about 700 ft., of which the upper 100–150 ft. may carry gas. This structure arises from thinning of the interval between the Pecan Gap chalk and the Woodbine sand. The porosity of the producing sand is about 25%, and its permeability is high. In some parts there are shale-breaks in the oil-zone. A heavy gas-flow was encountered in the Eagle Ford overlying the Woodbine. It is possible that the structure is faulted. Brief details of the logs of the few wells are given, and the indications are that the wells will average 4600–4900 ft. in depth.

Hawkins was outlined by surface, subsurface, and geophysical data, but the producing limits are not yet fully defined.

Brief details of the drilling procedure are given. The formation pressure is 2200 lb./in.^{2} Two electrical logs of the formations are appended. G. D. H.

340.* Better Concept of Faulting Patterns Aids Piercement-Dome Development. M. M. Kornfeld. *Oil Wkly*, 10.2.41, **100** (10), 19.—Faults may dislocate cap-rock and flank production around salt domes so much as to make ordinary means of exploration so hazardous as to require excessive uneconomic drilling to find production. Now experimental master-fault systems can be superimposed on salt-dome maps to help in locating fault-zones which would ordinarily be discovered only by drilling. Experiment shows that there are peripheral and radial faults, and their presence has been demonstrated on piercement salt-domes. The radial faults may be variable, but the pentagonal plan seems to dominate. Peripheral faulting leads to barren zones between the cap-rock and flank producing areas. The experimental work has indicated lines of attack which are superior to the old trial-and-error methods. A knowledge of salt-dome fault patterns assists in the interpretation of soil surveys.

On the Gulf Coast flank production may come from the Frio, Vicksburg, Jackson, Cockfield, Yegua, and Cook Mountain. Deep-seated salt-domes have given oil from the Mount Selman and Wilcox. G. D. H.

341.* Well Completions this Year Run Below 1940 Curve. L. J. Logan. *Oil Wkly*, 10.2.41, **100** (10), 33.—Although drilling activity fell early this year, it may rise later. The war is partly responsible for the fall, which may be partly offset by the rise in drilling which will undoubtedly take place as a result of increased industrial and commercial activity.

In 1939 and 1940 there were increases in the average output per well, those averages being 9·1 and 9·2 brl./well, respectively. The output per well in 1939 and 1940 rose in Arkansas, Illinois, Indiana, Kansas, Mississippi, Montana, Nebraska, and Wyoming, but it fell in California, New Mexico, Oklahoma, and Texas.

Drilling in January 1941 in U.S.A. was 13% below the level of drilling in January 1940. Tables give the completions by States for January and December 1940 and for January 1941, and the types of completions are listed. The drilling activity at the beginning of January 1940 is compared with that on 1st January and 1st February, 1941. G. D. H.

342.* Northern Hemisphere Offers Greater Oil Possibilities. W. V. Howard. *Oil Gas J.*, 9.1.41, **39** (35), 14; 6.2.41, **39** (39), 16.—Geologically and geographically the world's oil production can be divided into three nearly equal parts—Tertiary production in North America, Tertiary production in the rest of the world, and Mesozoic and Palæozoic production in North America. From a geological point of view the world can be considered as having northern and southern hemispheres which have similar elements—namely, three large and some smaller shields of pre-Cambrian and other metamorphics, surrounded by relatively undisturbed sediments and elongated arcuate chains of folded rocks, but in detail there are differences which bear on the possibilities of finding oil, especially in the Palæozoic and Mesozoic.

The southern hemisphere has five fragments of a former continent, but much of it has been submerged for only relatively short periods. In the late Palæozoic it was extensively glaciated, the glacial deposits burying the older rocks and being succeeded by a great thickness of continental beds. These mask almost all pre-Pennsylvanian structures and reduce the effectiveness of geophysical work. This continent began to split up in Triassic times, and later there were extensive outpourings of basaltic lava. Sedimentaries were laid down in the Amazon valley area and North Africa, making possibilities of oil like those of Wyoming. Hence, practically only the margins of the fragments of the southern continent have good oil possibilities. Gently folded Mesozoic and Tertiary beds and some wedges occur (*e.g.*, Egypt, Argentine). It is in the great folded belts of the north and west of this former southern continent that most of the oil of the southern hemisphere is found.

The northern hemisphere had no Palæozoic glaciation, and the Pleistocene glaciation was not extensive in possible oil regions. The Hercynian folding added much to the northern continent, and there were many opportunities for oil formation and accumulation. Thus multiple oil-plays were formed in North America. Palæozoic flysch areas occurred in North America, south-west of Fenno-Scandia, the Russian platform, and Western Siberia. Hence Russia has two areas potentially like the mid-Continent region of North America.

In addition to oil in flysch deposits, it is found in more extensive limestones and sandstones which give oil on broad regional features. In the mid-Continent, Russia, and West Siberia such deposits from shallow extensive seas were laid down.

Mesozoic and Tertiary sea invasions took place in Wyoming and Montana, and Germany's fields are of this type, as are also those of the Emba region and Turkestan. A Mesozoic sea invasion from the south was extensive only in U.S.A.

The Andine Revolution, which culminated in the Cretaceous, affected a belt from Antarctica to Alaska. Oil accumulations are associated with it in various parts of North and South America. It swings south through Japan and Borneo, where some oil has been found, but these regions are far from fully tested. Much of the length of the Alpine chains lies on highly folded Palæozoic, with the consequent minor oil possibilities, but in the open-folded flysch areas prospects are better. There are better oil chances in the southern ranges of this system—Iraq, Iran, Burma, East Indies, etc. The structure and deposits of the Gulf Coast of Texas and Louisiana are almost unique.

The various oil-field types are tabulated with examples, and a number of diagrams are included. G. D. H.

343.* Well Logs and Field Data of Active Oil Areas—Southern Mississippi. Anon. *Oil Gas J.*, 6.2.41, **39** (39), 42.—Before the discovery of Tinsley in 1939 the only Mississippi production was from the Jackson and Amory gas-fields. Ninety-six wildcats were drilled in 1940. Tinsley produces from five sands in the Selma, Eutaw, and Tuscaloosa of the Upper Cretaceous. At Pickens production is from the Wilburn sand of the Eutaw.

The principal structural trend is a continuation of the Cincinnati–Nashville arch. The Tinsley dome is an uplift on the north-east flank of this major structure. In the southern part of the State are east–west structures, of which the Hatchetigbee anticline is the chief. More than 150 wildcats have been drilled in Mississippi, but many were poorly located with regard to structure or were not drilled sufficiently deep. South of the Yazoo county fields the Eocene–Wilcox would appear to have as good possibilities as in the west. Drilling around the salt-domes has not yet been successful. Palæozoic rocks in Mississippi are known to be asphaltic at outcrop, especially in the Mississippian. Thus they may yield oil at depth. Amory gave gas from the Hartselle

sandstone (Mississippian). One of the difficulties has been that of interpreting geophysical data satisfactorily. The Tinsley reserves are estimated at 37,000,000 brl.

A geological map, stratigraphical column, and a series of well sections are included.

G. D. H.

344.* Importance of Two California Discoveries Yet Undetermined. L. P. Stockman. *Oil Gas J.*, 13.2.41, **39** (40), 26.—A 100-brl. well was completed recently in the Union Avenue district of Kern Co. It was brought in in the Santa Margarita at 5275–5315 ft. The Pliocene Kern River and Chanac series were barren. A well in this area had previously been taken to 10,427 ft. without success. A 100-brl. well was also brought in in the Newhall district of Los Angeles Co. It is on the Hasley anticline of the Newhall–Castiac region, and gives oil from the Modelo at about 2415 ft., a much less depth than was expected. Both areas need further testing before their potentialities can be assessed.

G. D. H.

345.* Air Photography and Geology.—R. W. Willett. *N.Z.J. Sci. and Tech.*, July 1940, **22** (1B), 21 (B).—The development of the use of air photographs as an aid to geological work in New Zealand is described and a detailed discussion is given of the difficulties, results, and possibilities of interpretation of geological features from air photographs. Air photographs in oil geology have given a great impetus to interpretative technique and hold to-day a recognized place in the mapping of petroleum-bearing areas. The delineation of anticlines, synclines, faults, dips, strikes, etc., are discussed in detail. A section is devoted to the relative costs of air-photographic and ground-survey work. A good bibliography is appended.

B. M. H. T.

Drilling.

346.* Selection of Wire Rope for Rotary Drilling Lines. H. F. Simons. *Oil Gas J.*, 23.1.41, **39** (37), 32–34.—As far as the rotary-drilling industry is concerned there are two types of wire lines used. One is the 6-by-19 Seale-type, regular right-lay, round-strand construction, and the other is the 6-by-19 Seale, Lang-lay, flattened-strand construction; the latter is generally furnished preformed. The 6-by-19 Seale-type wire line has six strands, each strand of which consists of a core wire surrounded by nine inner wires of uniform but relatively small size, and on the outside by nine wires of uniform but relatively larger size. Variations of this type-line (used elsewhere than in the oil industry) may have a different number of wires than nine, but the principle of construction remains the same.

The term " Seale " means that there are two layers of interlocking wire, the outer layer set in the valleys of the layer beneath. For ropes of the same diameter the outer wires of a Seale-constructed rope are larger components of the strand, and thus offer more resistance to abrasion. High resistance to abrasion is particularly important in the drilling industry.

The lay of ropes is discussed, and the regular lay is compared with the Lang-lay for drilling purposes. Grades and materials used are studied together with ultimate strengths. The paper is the first of a series, and deals mainly with the manufacturing side of wire ropes.

A table gives the sizes of lines for different jobs, and formulæ enable one to calculate block efficiency of line systems.

A. H. N.

347.* Rotation of Casing while Cementing. H. F. Simons. *Oil Gas J.*, 23.1.41, **39** (37), 50.—A method of rotating casing while cementing is described. After the casing has reached bottom and circulation has been established, rotation of the casing is started. The cement is mixed and pumped into the pipe with the weight of the slurry kept between 15·6 and 15·7 lb./gal. As soon as the cement has been pumped into the pipe, the regular plug is placed in casing and displacement begun with mud, a weighted measuring line following the plug to check its position and the position of the cement. Rotation of the casing is maintained to ensure the even distribution of the cement.

From 25 to 30 r.p.m. of the casing has been used in the Cumberland field during the time the cement was being displaced. The time required for this is generally about

15 min., although the time varies, depending on the fluid capacity of the pump and the horse-power of the driving end.

The tool used for supporting the casing while rotating has a tool-joint box for screwing on to the swivel on one end, and a becket and pin, which is placed through the single-ball elevators. It has no name, although some call it a "circulating hood." The tool-joint box has an A.P.I. left-hand thread to match the pin on the swivel. This special tool has a 2-in. connection to which a flexible steel hose is attached for conducting the mud and cement from the swivel to the regular cementing head. Elevator bails, hose, and casing all rotate together. The drive is through the rotary table by means of clamps. A. H. N.

348.* Factors Affecting Wear of Rotary Drilling Lines. H. F. Simons. *Oil Gas J.*, 6.2.41, **39** (39), 34–35.—During the past 10 years the footage drilled with one change of rotary drilling lines has more than doubled, due to the improvement in the quality of the wire rope, increase in the rate of penetration and weight carried on the bit, better-designed and more appropriate drum and sheave sizes, and a wider knowledge of the proper installation and care of this particular piece of machinery.

There are several points where the wear on the line in the derrick and through the blocks is concentrated. The first of these is at the drum when the travelling block is: (*a*) as close to the floor as it gets while pulling or running-in drill-pipe; (*b*) as close to the crown-block as it gets while making a trip; (*c*) about 40 ft. off the floor, the position it is in when breaking out or adding a joint of pipe. The second main point of wear is at the crown-block when the travelling block is in each of the three positions listed above. A third is at the fast sheave on the travelling block in each of the same positions. It is possible to observe these facts and to minimize their effects by changing the position of the drilling line.

Factors affecting the wear on wire rope, such as diameter and grooves of sheaves, diameter of drum, lubrication, and fleet angle, are discussed. All these must be within certain limits to give minimum wear. A. H. N.

349.* Unusual Conditions in Deep Coastal Wells Present Completion Problems. N. Williams. *Oil Gas J.*, 13.2.41, **39** (40), 42–44.—In several Gulf-Coast fields in which development of productive sands at depths below 11,000 ft. has been undertaken within recent months, control and completion of wells have presented a number of new problems. Not only have high pressures been encountered, but high temperatures, hot salt-water flows, and excessive sand conditions have added to the difficulties of maintaining properly conditioned drilling mud to combat the pressures. Completion of wells at these depths has been complicated by the use of heavier muds which have been made necessary by the high pressure and unusual conditions which have had to be overcome.

Detailed drilling and control practices are given for typically difficult cases. Mud control is of the utmost importance in these fields. Three distinct means are employed in determining any change in mud and mud weights due to presence of gas or other conditions. First, there is the mud analyser, or hydrocarbon detector. Second, a continuous recording mud-weight indicator is provided. The third is to keep a close gauge of the amount of mud in the pits, the height of the mud in the pits being a ready indication of gas or other changes in mud condition.

Successful completion practices under difficult conditions are described.

A. H. N.

350.* Installation of Wire Rope used for Rotary Drilling Lines. H. F. Simons. *Oil Gas J.*, 20.2.41, **39** (41), 53.—A great amount of damage is often done to the wire rope while it is being installed on a rotary and drilling rig, and proper handling during this procedure will result in added service. Kinks in the line should be prevented at all costs, and the line should be spooled evenly and smoothly on the drum.

General practice is to jack up the reel, using as large a piece of pipe as possible through the centre of the reel for an axle. The free end of the rope can then be pulled to the derrick. After laying down the blocks, the free end of the new line is fastened to the dead end of the old line, and, by winding the old line on the drum, the new line is threaded through the blocks. If a guide-pulley is needed on the derrick floor it

should be large enough to prevent kinking of the strands in the wire rope; a tubing block is excellent for this purpose.

The first layer of wire rope should be spooled on the drum tightly. This can be accomplished by putting a brake or weight on the reel, by attaching the cat-line to the fast line just under the crown-block, and then holding a strain on the cat-line as the line is wound on the drum, or by fastening a manila rope about 40 ft. up in the derrick and taking eight or ten wraps around the line; a tension on the free end of the manila rope automatically tightens its grip on the wire line. To prevent bending of the girts a bridle may be swung from the derrick legs for attachment of this tightening line.

Similarly other detailed procedures for safely installing wire ropes are given and illustrated. A. H. N.

351.* Occurrence and Treatment of Heaving Shale. Anon. *Oil Gas J.*, 27.2.41, **39** (42), 76.—No widely accepted explanation of the cause of heaving amongst certain shales is known. Instances are reported where the heaving shale cores have literally exploded on the derrick floor on removal from the core barrel. It is widely recognized that the presence of bentonitic material in the shale (which has the well-known property of expanding when saturated with water) is a contributing factor in the heaving action, but other conditions must coexist. In Wyoming, for example, the highly swelling bentonite does not cause heaving difficulties. It is possible that a steep angle of repose of the bentonitic stratum may be the coexisting condition necessary to start slipping and consequent plastic flow.

As bentonite is so important in these studies, a method of identifying montmorillonite, its most common component, is given. Benzidine is slightly soluble in water (about 0·5%); hence a saturated solution is readily prepared by shaking the benzidine with water. This, when packed in a small bottle, is the reagent. A small white test-plate, dropper, and penknife complete the equipment. When a sample of clay is to be tested, a small amount of dry clay is placed on the test-plate; a few drops of the benzidine reagent are used to wet it, and if a vivid blue colour results, montmorillonite is probably present. The test is sufficiently sensitive that the clay can be diluted with 500 parts of inert material and the blue colour will still show up when benzidine is added.

Various aspects of the problem are discussed and three principal routes of attack on the heaving shale problem are pointed out—*e.g.*, a minimum water loss, a minimum of base exchange, and a high specific gravity. The former two prevent swelling of the bentonite which causes the heaving, and the latter helps to prevent any movement of the formation into the hole. The use of starch is a new development, and is still in the experimental stage. Those familiar with this treatment have high hopes for its success in the combating of heaving shale as well as the solving of other problems. Also, in very recent months a treatment using sodium alginate has been brought before the industry. A. H. N.

352.* Improvement in Plastering Properties of Muds. H. T. Byck and J. W. Freeland. *Oil Wkly*, 3.2.41, **100** (9), 26.—The paper deals with the colloidal factors affecting plastering properties of muds. The effects of extraneous factors on these properties are also briefly discussed. Experiments are described in which the use of sodium alginate and of Irish moss to improve the plastering properties of muds is studied. Optimum concentrations, method of use, the fermentation of muds containing these materials, and methods of reducing fermentation troubles, effects of high temperatures, etc., are also studied. The conclusions reached consequent on these studies are:

The use of Irish moss or sodium alginate in relatively low concentrations may be expected to improve the plastering properties of muds, to protect them against salt contamination over the range of normal contamination concentration, to permit the use of sea-water to prepare muds of excellent plastering properties, and to permit the use of saturated brine muds, likewise of excellent plastering properties.

Furthermore, special-purpose muds, such as straight-carbonate muds, can be given excellent plastering properties.

For salt concentrations resulting from normal contamination 0·2% protective agent (by weight of total mud) should be adequate; for sea-water muds and saturated brine muds concentrations between 0·2% and 0·6% are recommended.

A field trial of the method has met with success. A. H. N.

353.* Rapid Penetration with High Rotary Table Speeds. Anon. *Oil Wkly*, 10.2.41, **100** (10), 12–14.—Speeds of 450 and 500 revolutions are being obtained with present materials and equipment. While tables are being manufactured and tested at 1000 revolutions per minute, drill-pipe strings permitting continued use of such speeds have not been assembled.

In order to get satisfactory service from equipment at 500 revs./min, it is necessary that many units be synchronized, and several problems remain to be solved before speeds of 750 or 1000 revs./min. can become common.

The kelly assumes a distinctive importance when used with high table speeds, and octagon and hexagon styles are both used. The conventional square kelly is not employed with high table speeds for several reasons, among which is a tendency for mechanical binding at the corners of the bushing that prevents the stem from floating freely through the table while making hole. When unit of a machine is rotating at high speeds, it must possess inherent stability or excessive vibration, and whipping will develop.

The care necessary to apply to the 18-ton drill collars, to the drilling stem and bits, and to the mud system is detailed. When every care is taken, it is possible to drill with high table speeds so that a new connection is required every 12 minutes. Mishaps are not frequent if reasonable precautions are taken. A. H. N.

354.* Principles of Drilling Mud Control. Part 1. S. J. Pirson. *Oil Wkly*, 10.2.41, **100** (10), 21.—The paper forms a co-ordination of available information on the behaviour of drilling muds rather than an original contribution by the author. In Section 1 the origin of clays and general results of weathering processes yielding clays are studied. In the second section the physical properties of clays are reviewed. The primary effect of the weathering process is to reduce the original igneous rocks into small particles, the size of which will vary greatly according to the composition and physical character of the mother rock, the predominant type of weathering, the mode of transportation, and concentration.

A corollary of the extreme division of clay particles is the enormous increase in the extent of the surface of the particles for a given unit weight of clay. The increase in surface is inversely proportional to the diameter of the particles. Thus if a cube of 1 cm. edge length having a total surface of 6 cm. is divided into cubic particles 0·0001 mm. in size, the total surface will be 600,000 cm. But clay particles usually possess a porous or capillary structure, and the increase in specific surface due to the extreme division of clays is even greater than the relation given above. Finely divided particles have the property of forming colloidal suspension with liquids; clays in particular will readily be suspended in water and will form a heterogeneous dispersed system called mud. Due to the great extent of the surface of the particles so dispersed, surface energies and surface forces predominate to the practically complete exclusion of chemical forces. Therefore the chemical composition of the clay particles dispersed in water is of little concern in studying the effect of adding chemicals to a mud. This is extremely fortunate, since many clays of greatly varying chemical composition will react in the same manner to a given chemical. The use of Stokes' Law for measurement of particle size is detailed.

Section 3 deals with chemical properties of clays, and is of interest to mineralogists rather than to drillers. However, the section following deals with the chemical properties of clay suspensions or colloidal suspensions. Materials in this state are distinguished by three properties: (1) a great effective surface or interface; (2) a capacity to fix solids, gases, and ions of salts in solution (strong adsorption); and (3) a tendency to hasten or retard chemical reactions (catalytic effect).

One of the outstanding characteristics of the colloidal complex of clay in suspension is the ability to adsorb cations which are held on the colloidal nuclei in a replaceable condition. The adsorption for cations of the colloidal clay is considerably larger than the adsorption for anions. All cations are not adsorbed to the same extent on the clay particle; monovalent cations are adsorbed according to the following scale of intensity: $Cs > Rb > NH_4 > K > Na > Li$, lithium being the least strongly adsorbed of all ions. The bivalent ions are more strongly adsorbed than the monovalent ions according to the following scale of intensity: $Ba > Sr > Ca > Mg$, barium being the most strongly adsorbed. Of all ions, hydrogen is the most strongly adsorbed. When found in nature, clays are not devoid of adsorbed ions. Their presence is undoubtedly

responsible for the variable behaviour as drilling muds which is observed in clays seemingly physically alike. Before any two clays can be compared from the point of view of rotary-mud making, it is necessary to know what kind of ions are adsorbed on the clay and in what amount.

The purification of clays from their adsorbed ions by electrodialysis and the characteristics of these ions, together with the concepts of exchange neutrality, exchange acidity, of buffered colloidal electrolytes, and the interpretation of p_H values of clays are all well explained in this long article. A. H. N.

355.* Principles of Drilling Mud Control. Part 2. S. J. Pirson. *Oil Wkly*, 17.2.41, **100** (11), 20.—The fifth section of this paper deals with the physical properties of muds, as these properties are the most important in ordinary rotary drilling. Drilling mud being a heterogeneous fluid, the weight/unit volume is equal to the weight of the liquid + weight of the suspended particles. If the quantity of clay added/gall. of water is known, the density of the mud in lb./gall. (d) is readily calculated by means of the following relation :

$$d = \frac{W_1 + W_2}{1 + \frac{W_2}{8{\cdot}33\rho}}.$$

Weighting materials are discussed, including galena, which has not yet been used for this purpose.

Einstein's equation does not apply satisfactorily to the calculation of mud viscosities, because the clay particles generally do not behave like independent spheres, nor do they retain their original volume ; each of the particles in suspension adsorbs a more or less thick hull of water, which increases considerably the volume of the dispersed phase. However, under certain conditions of treated muds by viscosity-reducers Einstein's equation is observed.

Many factors affect the viscosity of clay suspensions : concentration, temperature, degree of dispersion, solvation, electrical charge, presence of electrolytes, and rate of flow. Each of these factors is separately discussed.

Thixotropy and gelation are defined and their mechanism is conventionally explained. The value of p_H on gelation rate is not settled. Other factors which affect the gelling rate of a clay suspension are : the temperature, the degree of dispersion, the electrical charges, the valence of the electrolytes present, and probably many others as yet undetermined. It has been established that the gel rate will be considerably increased by polyvalent ions. An increase in temperature decreases the gel rate in an irreversible manner. This is important in deep drilling, when a mud may be operating at a fairly high temperature, and should the gel rate and gel strength become unduly reduced there would be danger of the drill cuttings settling during a shut-down period.

The addition of a finely divided clay will increase the gelling rate as well as the gel strength of a drilling mud.

Rheopexy is a phenomenon related to thixotropy in the sense that rheopexy is an acceleration of the gelation rate induced by mechanical action, such as rolling the fluid container around a certain axis or by gently tapping the container. The phenomenon has to do with the orientation of anisometric particles (rod-like or plate-like). The acceleration of the gelling rate may be quite considerable.

Dilatancy, swelling, flocculation, and deflocculation of muds (and methods of stabilizing mud colloids), adsorption of gas or gas cutting, and the filtrability of muds are all studied in some detail, the probable mechanism, methods of enhancing the favourable properties, and means of measuring them being also given.

Six functions of muds of general use and the special problem connected with heaving shales and mudding off producing formations are outlined. Methods of logging muds are briefly reviewed. The exhaustive paper contains a good list of selected references. A. H. N.

356.* Development of Shooting Practices for Multiple-Zone Completions. R. C. Graham and J. R. Thompson. *Oil Wkly*, 24.2.41, **100** (12), 21–25.—Removable windows are formed of sections of magnesium or aluminium-base-alloy pipe particularly suitable for the application. The magnesium-alloy casing is soluble in acids and to a certain extent in salt water, making its installation of a temporary nature. This type

of window is removed by the circulation of inhibited acid, and requires only some means of running tubing, which can be done with a spudder-type drilling machine. However, the aluminium-alloy window does not react satisfactorily to acid treatment for removal. Other methods are described. Finally, the method advanced was the destruction of a magnesium-alloy window by nitroglycerin. This method was suggested not because of the dissatisfaction of the removal by acid, since acid removal had been highly successful, but rather as a means of hastening the completion process. Most sands now producing in the Illinois Basin require a nitro shot to produce efficiently, and if the window could be removed as the sand was shot, a double purpose would be achieved and one step in the completion process eliminated, with resultant savings. Difficulties encountered and methods used to overcome them are detailed.

Three methods of removal by shooting are being used. Apparently each method is accomplishing the desired purpose satisfactorily, with individual operators expressing preference for each method. The first method is to rip the window with a cable-tool ripper prior to shooting. The second is to bridge above and below a window which has not been ripped, and then to shoot it. The third method is to use squibs. This method is gaining popularity rapidly, and will probably supersede methods 1 and 2. A 16-in. squib containing three-quarters of a quart of liquid nitroglycerin is lowered into the hole on the shooter's wire line to a point just above the bottom of the window. A 3-oz. weight is then dropped on the wire line, which detonates the shot. The wire line is then removed and the process repeated 16 in. higher than the first shot. This procedure is repeated until the window is removed. Where a bridging plug has been placed in the lower steel section, the particles resulting from the shot are trapped and removed from the hole with a sand-pump. If this method of shooting does not cause the sand to react as expected, the formation is re-shot similar to method 2, utilizing the bridging plug as a base for the plug-back.

Details and costs are given. A. H. N.

357.* Portability in a Rig Set-up. Anon. *Oil Wkly*, 24.2.41, **100** (12), 39–40.—Methods of reducing down-time while drilling, and of simplifying movement of equipment from location to location, are gaining increased attention from drilling contractors. The set-up described in this paper, used to drill to 5734 ft. in South-west Texas, employs many features that might be advantageously employed on other rigs.

One of these features is a 92-ft. derrick which breaks down into three sections for convenient movement by truck. A. H. N.

358.* Hydraulic Couplings Promote Flexibility in Power Control of Drilling Equipment. W. A. Sawdon. *Petrol. Engr*, January 1941, **12** (4), 66.—The paper deals specifically with a particular rig using hydraulic couplings and recently used to drill a 10,000-ft. well. From the specific studies certain generalities, however, become apparent.

Of the many points discussed the following deserve special mention. The most experienced drillers frequently stall the engines with a conventional drive, either through improper synchronization of clutch and throttle or in attempting to lift too great a load. With hydraulic couplings installed it is impossible to stall the engines by over-loading. The performance characteristics of these couplings are such that full engine torque is not delivered until they reach a certain speed, which is usually approximately half the rated engine speed. At this point the hydraulic couplings will deliver full engine torque, but will slip as much as 100%. As the engine speed is increased the slip becomes less, until at rated engine speed the slip is between 3 and 4%.

This action permits the hydraulic coupling to be used as a clutch, although in ordinary operation this is not done because of the few seconds' additional time required. In an emergency, however, this feature may be successfully employed. At the other extreme the driller can wait until the hydraulic couplings are at full speed and at minimum slip before engaging the mechanical clutch. If this is done the load may be hoisted with a very rapid acceleration, and lifting time is reduced. Obviously the shock involved by this action is great, and when frequently repeated may ultimately cause some damage to the rest of the machinery.

As slippage is a definite feature of the hydraulic coupling the heat generated during

slippage must be dissipated. It had previously been determined that the coupling itself would dissipate the heat accompanying approximately 7–10% slip by convection without the oil becoming dangerously heated. Beyond this amount of slippage the heat generated in the oil induces disintegration, and some provision must be made for cooling the oil. This condition occurs frequently with the mud-pump drives.

The mechanics of the coupling and the scoop-tube for control of speed are well illustrated. A. H. N.

359.* New-Type Boiler Plant for Steam Drilling-Rig. W. A. Sawdon. *Petrol. Engr*, February 1941, **12** (5), 21–24.—The first steam-generating plant utilizing water-tube boilers specially designed for drilling is described and illustrated diagrammatically and photographically. The plant consists essentially of two Foster–Wheeler specially designed water-tube boilers with evaporator, condenser, and three cooling towers. Unit design to provide complete portability is employed throughout, the evaporator and feed-water pump unit and the condenser, feed-water tank, and circulating pump unit for each boiler being mounted on steel skids. Flanged headers are used for connection between units. The portable cooling towers are natural draft units equipped with hose connections to give flexibility in setting up.

The cost of this plant complete is approximately the same as that of the modern conventional boiler-plants now in use for comparable duty. As the boilers use only distilled water and can be operated with any kind of raw water supply, the reduction to a minimum of the expensive troubles caused by bad water is anticipated. Other features considered in selecting the installation include a substantial reduction of fuel-gas consumption, increased safety, lower maintenance costs, and decreased weight and bulk/unit of steam capacity. Under maintenance considerations were the elimination of scale, no stay-bolts to keep tight, and no flues to roll and re-tip. In regard to safety was the fact that there is no appreciable hazard from steam explosion. Conservation of water was also considered; exhaust steam from pumps and engine is returned to the condenser with an allowance of approximately 10% of the total steam load and leakage and waste to be evaporated from raw water. Should this type of plant be used for barge drilling, no cooling towers would be necessary.

Each item of the equipment used is described separately. A. H. N.

360.* One Derrick Serves Five Wells. J. C. Albright. *Petrol. Engr*, February 1941, **12** (5), 46.—As a part of the programme by which a large number of directional, or "slant-hole" wells are being currently drilled at Huntingdon Beach, California, an interesting plan has been adopted whereby one derrick is made to serve the needs of five wells. Initial investment is, of course, reduced, but a more important reason for devising the multi-purpose derrick was to overcome the handicap of close spacing between the slant-hole wells.

The directional-drilling programme is on a narrow tract on which a number of vertical holes had been drilled in a straight line parallel to the beach several years before. A second row of producing wells, also vertically drilled, is situated near the cliff on the beach side of the boulevard. The need for the slant-hole wells is based on the presence of an oil-zone off-shore, so that the bottoms of wells producing from the formation are about 1500 ft. distant from a vertical line projected through the well-head.

The programme as approved calls for a group of five slant-hole wells to be completed between two of the vertical wells—all to be in a straight line. Ultimately, eighty-five of these wells are to be drilled, consisting of seventeen groups of five wells each.

The derricks, drilling strings, pumping units to be used in production, and metering arrangements are described. A. H. N.

361.* Steel Tanks *v.* Open Pits for Drilling Mud. H. L. Flood. *Petrol. Engr*, February 1941, **12** (5), 106.—It would appear that regardless of the theoretical advantages that steel storage might have, open earthen pits will continue to be used in most drilling operations. Other than in those instances in which steel storage for mud is an absolute necessity, the most valid reason for using steel tanks elsewhere concerns the saving that can be effected in the amount of purchased mud ingredients required.

When a location is to be made in an area where it is known that special attention must be given to mud conditioning, it is suggested that a careful study be made of the cost of steel storage and of the savings that might result from its use. A. H. N.

362.* Welding Tool Joints on Drill Pipe. C. M. Taylor. *World Petrol.*, February 1941, **12** (2), 46–47.—To avoid loosening of tool-joints in service, particularly deep wells, many producers are welding the tool-joints at both ends of every section of pipe. A well-detailed and illustrated account of these operations is given. To appreciate the method of the welding process the diagrams must be studied.
A. H. N.

363.* More Records Established in Wasco Field. Anon. *Petrol. World*, January 1941, **38** (1), 40.—Deep well drilling in record time is described. The total time for drilling three 13,000-ft. wells was 99¼ days. Great emphasis is laid on the control of the mud fluid—the largest mud pumps in the world being used. The rig, and equipment, including the four 130-h.p., 350-lbs./sq. in. boilers, are briefly described and illustrated photographically. A. H. N.

364. Rôle of Clay and Other Minerals in Oil-Well Drilling Fluids. A. George Stern. U. S. Bur. Mines. Report of Investigations No. 3556, February, 1941.—This report was prepared with a view to supplying to the clay industry information concerning the types of minerals used in the preparation of drilling mud, their requirements and limitations. It is thus addressed primarily to the non-metallic industry, but at the same time it contains suggestions and ideas which may proved helpful to petroleum production and exploitation personnel.

The data have been collected from a variety of sources, and more particularly during field trips to laboratories where the mud is tested, to producers of the minerals used in making the mud and to actual oil-fields where drilling-mud problems have occurred.

The report embodies *inter alia* sections on the functions of drilling mud, geology and related drilling-mud problems, testing of mud, materials used and control of properties.

In summarizing his findings, the author emphasizes the necessity for carefully controlled mud characteristics, and indicates various methods of measuring clay and mud properties. In particular the filter test is to be recommended as providing a means of measuring how thin a layer of mud will form a film impermeable to filtration of water or other liquid. In other words, it enables an assessment to be made of the ability of the mud to plaster the oil-well sides with a wall-like coating.

One of the chief desiderata of a drilling fluid is that any of its physical properties should be capable of adjustment without appreciably affecting the others. For instance, in certain cases specific gravity can be increased without appreciably affecting viscosity. Optimum characteristics of a drilling fluid can only be determined by careful scrutiny of its functions. Removal of cuttings from the well as rapidly as possible involves a high linear velocity for the mud fluid. To hold the cuttings in suspension and prevent their settling when drilling is temporarily stopped calls for certain gel characteristics which will permit the fluid to thicken when undisturbed. To consolidate loose formations encountered in drilling, the fluid must have adequate density and the quality of building a thin impervious, tough wall in the hole.

Additionally the fluid should be capable of acting as a lubricant and cooling medium for the drill system and bit, it should be easily pumped without too great expense of power, it should not separate on standing and, above all, it should be flexible as regards properties but not susceptible to outside influences such as temperature or the flocculating action of salt-water.

Summarily a drilling fluid should approximate as nearly as possible to the following description. "A low-cost, low viscosity, high density, stable fluid of which no portion will pass through a filter, independent of the flocculating action of salt-water or the influence of temperature variations, and having the unusual characteristic of setting as a gel when allowed to remain quiescent but becoming extremely fluid when agitated."

No one mud can fully comply with these requirements, since certain conditions directly oppose each other. Nevertheless a fluid can be obtained which possesses most of the properties to a fair degree and which is capable of modification to increase any one of the properties.

The amount of clay used in oil-well drilling is great, and some of it is sold at a high price per ton. By far the greatest bulk is, however, of the "back-yard" variety, and is sold at a price only slightly above the cost of handling. Expense is nevertheless involved in technical control of mud characteristics, and it is for the clay industries to recognize that profit lies not so much in the material they have to offer, but in the degree of professional skill and technical expertness with which it is prepared for use in drilling fluids. H. B. M.

365. Patents on Drilling. G. A. Lowrey. U.S.P. 2,229,331, 21.4.41. Appl. 13.2.39. Outside pipe-cutter adapted to cut by rotation and shaped to telescope over a pipe stuck in a well-bore.

L. D. Ekin. U.S.P. 2,229,408, 21.1.41. Appl. 16.2.38. Mechanism for driving pipe for use with the drill-string in the cable system of drilling.

L. R. Croft and C. S. Sanders. U.S.P. 2,229,493, 21.1.41. Appl. 11.1.40. Method and apparatus for completing wells comprising the lowering of a screen during drilling.

C. A. Yeatman. U.S.P. 2,230,280, 4.2.41. Appl. 26.4.39. Hydraulic head integrator of relative vertical motion adapted to be used in drilling-time studies, consisting of a closed liquid container and a pressure recorder.

R. Bassinger. U.S.P. 2,230,447, 4.2.41. Appl. 26.8.39. Well-plug for cementing casing which can be set in a well and removed after the cementing is removed.

A. W. J. Bromley. U.S.P. 2,230,581, 4.2.41. Appl. 30.1.39. Hoisting cable which has a weight-supporting multistrand outer sheet, a non-weight-supporting core, and an electrical conductor inside the core.

D. Breeding. U.S.P. 2,230,522, 4.2.41. Appl. 23.7.38. Well-drilling mast comprising a pair of standards with pulley arrangements at the top.

J. H. Howard and A. C. Catland. U.S.P. 2,230,568, 4.2.41. Appl. 14.10.38. Core-drill for rotary drilling apparatus.

J. H. Howard and W. H. Maxwell. U.S.P. 2,230,569, 4.2.41. Appl. 20.12.39. Roller cutter.

C. H. Miller. U.S.P. 2,230,626, 4.2.41. Appl. 16.8.38. Means for recovering cemented well casings by using a rubber-jacketed casing.

W. Bendeler and C. Howard. U.S.P. 2,230,712, 4.2.41. Appl. 11.4.40. Well-bridging plug.

A. D. Maclachlan. U.S.P. 2,230,723, 4.2.41. Appl. 21.1.38. Hose reinforced by a special reinforcing structure.

D. S. Hubbell. U.S.P. 2,231,123, 11.2.41. Appl. 17.1.39. Cementitious composition characterized by its resilience and strength under dry and wet conditions.

E. L. Knoedler, Jr. U.S.P. 2,231,166, 11.2.41. Appl. 20.6.39. Combustible gas indicator with a wheatstone bridge.

R. W. Schlumpf. U.S.P. 2,231,225, 11.2.41. Appl. 26.2.38. Tool-joint and method of making.

M. E. Norris. U.S.P. 2,231,282, 11.2.41. Appl. 22.1.40. Removable bridging plug for oil-wells.

A. Pfister. U.S.P. 2,231,283, 11.2.41. Appl. 29.7.37. Manufacture of Irish moss.

N. Blihovde. U.S.P. 2,231,284, 11.2.41. Appl. 29.7.37. Purification of Irish moss to obtain a high-viscosity comminuted colloid.

O. F. Simons. U.S.P. 2,231,328, 11.2.41. Appl. 20.11.40. Colloidal suspension

of dry extruded fuller's earth having an increase of 50% in its colloidal properties as compared to same earth which has not been extruded.

L. Gitzindanner. U.S.P. 2,231, 421, 11.2.41. Appl. 22.1.38. Colloid mill.

D. G. C. Hare. U.S.P. 2,231,577, 11.2.41. Appl. 29.5.40. Locating cement behind casing by means of mixing with the cement a substance capable of strongly absorbing slow neutrons and using a detector.

K. Burke. U.S.P. 2,231,613, 11.2.41. Appl. 3.4.40. Blow-out preventer and control lead.

A. J. Mason, Jr. U.S.P. 2,231,767, 11.2.41. Appl. 18.12.39. Open-hole support for supporting elements in a desired position in uncased drilled hole.

W. P. Bradley and H. M. Hicks. U.S.P. 2,231,794, 11.2.41. Appl. 23.11.38. Means for protecting pipe-ends.

A. R. Maier. U.S.P. 2,231,840, 11.2.41. Appl. 22.12.38. Travelling block.

J. M. Shimer. U.S.P. 2,231,843, 11.2.41. Appl. 25.9.37. Portable oil-field boiler with a superheater in communication with the smoke box.

A. Boynton. U.S.P. 2,231,878, 18.2.41. Appl. 22.9.38. Threadless drill-stem.

L. O. Koen. U.S.P. 2,231,923, 18.2.41. Appl. 2.12.35. Rotary slip.

W. Pate. U.S.P. 2,232,135, 18.2.41. Appl. 6.2.40. Replacement bearing sleeve for the couplings of drill-stems of oil-wells.

J. C. Fortune. U.S.P. 2,232,172, 18.2.41. Appl. 16.6.38. Rotary drilling snubbing ram.

L. A. Rawson. U.S.P. 2,232,268, 18.2.41. Appl. 12.9.38. Derrick crown construction.

A. R. Barnett. U.S.P. 2,232,360, 18.2.40. Appl. 18.10.37. Apparatus for surveying hose-holes, being a drill-pipe section adapted to receive surveying instruments.

S. E. Diescher. U.S.P. 2,232,593, 18.2.40. Appl. 1.2.39. Welded casing joint.

A. H. N.

Production.

366.* Diesels used in Pennsylvania Repressuring Project. A. C. MacIntyre, *Oil Gas J.*, 6.2.41, **39** (39), 36.—The first diesel-power installation used in secondary-recovery operations was recently placed in use in the middle district of the Pennsylvania fields, where since the early days gas has been generally used. The diesels are being used to permit conservation of natural gas for injection into the sands, where otherwise it would be used as fuel for power.

The plant is described in general terms. A. H. N.

367.* Pumping Equipment. H. F. Simons. *Oil Gas J.*, 13.2.41, **39** (40), 53.—The great bulk of wells in the United States have some type of rod or tubing pump with which to lift the oil. There are approximately 320,000 such wells in the country. Simplicity of operation, ease of adjustment over a wide capacity range, and low operating costs are the principal features of this method.

Plunger-type pumps are generally run on or in a string of tubing, although not necessarily so, casing pumps being quite common in wells where large volumes of fluid must be handled. The recent policy of some companies to drill unusually small-diameter holes has led also to considerable experimentation with the casing pump. Essentially it consists of a beam and rods which actuate a plunger at the bottom of the well. The plunger may be almost as big as the casing, or it may be as small as desired, depending on the amount of fluid to be handled and the size of the rod-string. Where

a small plunger is used, the casing pump has no more volume capacity than the regular tubing or rod-pump, the only advantage being the elimination of the tubing string. This advantage is offset by the danger of wearing a hole in the casing due to the repeated contact of the rods as they work up and down. A discussion of surface and subsurface equipment and details of operations to obtain efficiency follow.

Wells which have a high fluid capacity can often be operated economically with a pump which has no rods. There are two main types: bottom-hole centrifugal pumps driven by electric motors, and bottom-hole pumps actuated by hydraulic pressure. These do not need to be run at the bottom of the well, but are so called because they operate while submerged.

The electrical centrifugal pump is run in the well on the tubing with a waterproof cable connecting it to a power supply at the surface. The size of the pump and the size of the motor determine what its capacity will be. For this reason some wells on which high fluid output is expected are equipped with large casing. The hydraulic pump is also run in the well on tubing, but, in addition, it has a macroni string through which fluid (screened oil) pressure, created at the surface by a triplex pump, is transmitted to the pump at the bottom of the well; the exhaust from the pump in the well enters the production string of tubing.

Plunger lift is very briefly described. A. H. N.

368.* Acidizing Gas-Fields. G. Weber. *Oil Gas J.*, 20.2.41, **39** (41), 40.—The history of drilling and developing the Monroe gas-field is given. Recently the greatest well-acidizing programme of the industry was carried out in the field.

A number of the wells treated in the field had open-flow ratings of less than 1,000,000 cu. ft. daily. These were treated in three or more stages, with a usual acid programme of 500 gal. on the first stage and 1000 and 2500 gal. on the second and third stages.

On the larger high-pressure wells in the field, the regular grade of acid was used. In lower-pressure wells, usually below 300 lb./sq. in., shut-in pressure, a low-surface-tension acid was employed. This gave better penetration and, more important, was more readily blown from the formation when the wells were open-flowed. The benefits in using the low-surface-tension acid in such wells was proved by the contrast with a few cases using ordinary treatment. In such cases wells showed little gain in open-flow capacity, and a few showed even lower rates than before treating. Retarded acid was experimentally used, but proved of no particular advantage in chalk rock of the type producing gas at Monroe.

An important result in acidizing in the field was noted in the large amounts of mud which cleaned from some wells after acidizing. Although most such wells had been on production for several years and had been open-flowed at intervals without showing mud, the open-flow following the first acid stage contained quantities of mud together with the spent acid and water. This is believed to be explained by the fact that the acid cuts the mud either in the well-bore or in the formation, where it may be present in the form of a filter cake. A. H. N.

369.* Pumping Practices in Nowata Producing Operations. P. Reed. *Oil Gas J.*, 20.2.41, **39** (41), 42.—Operations in water-flooded fields are characterized by the individuality of each operation, in that even in the same property different methods are used. Thus while one operator decides to change from well pumping with time-controlled electric motors to central pumping, another reverses the procedure and changes from central pumping to the single-well pumping practice. In another field one row of centrally pumped wells alternates with another row of wells which are individually pumped.

For the requirements of numerous producers in the field, gas engines prove to be well adapted for economical operation. On the other hand, electric power has certain features which have been found to be desirable for water flooding. In fact it may be said that three of the conspicuous aspects of water-flooding operations in the last 5 years at Nowata have been the increased use of electric power, successful exploitation of reserves of siliceous lime-water by several operators in the area, and the economic advantages offered by the practice of producing water-flood production by flowing.

A. H. N.

370.* **Recent Trends and Success of Plugback Work in East Texas.** W. H. Wiginton. *Oil Gas J.*, 27.2.41, **39** (42), 64. *Paper Presented before American Petroleum Institute.*—The paper discusses briefly the older methods and gives a more complete discussion of the newer methods used in plugback work to shut off salt-water, showing past results of various methods that have been employed, and outlining the economics of this type of remedial work.

The cost of a majority of the workovers in the past has been entirely too high to justify the work—therefore the various operators have demanded that less expensive methods be developed whereby salt-water production can be profitably curtailed.

The older methods in use are: (1) pump bailer; (2) displacement; (3) bradenhead squeeze; (4) short-string squeeze; (5) retainer squeeze.

The more recent methods in use are: (1) removable cementing tools; (2) formation packers; (3) bridge plug or hook-wall packer between perforated zones. A new removable cementing tool offered by several service companies consists of cups and slips with a by-pass joint on top of the tool. On application of hydraulic pressure the cups expand thereby keeping the pressure off the casing. The slips are necessary to hold the tool and tubing or drill-pipe in the hole while the pressure is on the formation. After the required amount of cement is placed in the formation the tool is released, the excess cement is washed out by reverse circulation, and pulled out of the well. No appreciable amount of cement returns after the tool is released if the final pressure obtained is from 1800 to 3000 lb./sq. in. on the pump. Details are given.

A formation packer has been developed to provide an adjustable and removable pack-off between an upper and lower producing formation, where it may be impossible to predetermine exactly the most effective pack-off point. Some of the factors affecting the most desirable location of the packer which may be difficult and expensive to determine are: the absence or presence of a definite shale-break and its definite location; the size of hole below the casing seat; the condition of the well-bore in regard to caves, washes, etc., and by means of the formation packer, the pack-off point can be adjusted to give the most effective shut-off.

The third method is used where the oil-string is set through the sand section and the original completion of the well is through perforations. After water starts to enter the well, a higher zone is perforated and some type of bridging plug or hook-wall packer set between the two perforated zones.

Economics of remedial work is studied in brief, but the methods are well illustrated and detailed. A. H. N.

371.* **Seven-Year Trial Proves Gas-Injection Project Profitable.** Anon. *Oil Wkly*, 3.2.41, **100** (9), 16–20.—Injection of gas is being used primarily to increase the ultimate recovery, the immediate objective being control of reservoir conditions through input volumes and pressures. Both water encroachment and depletion towards an uneconomic operating level are being retarded by repressuring in a manner similar to recycling. By the time the last well is plugged the field will have produced 3000 brl./acre in excess of the recovery anticipated without repressure control. The history of the field—Cotton County, Oklahoma—is given.

The decision to repressure resulted from two individual factors. In the first place, water became a threat as early as 1932. While most of the water was coming in from the edges, due to decreased formation pressures, there was some water in the pay formation at different levels, to indicate that a complete separation of water and oil had been doubtfully established in the reservoir. This water could not be made subject to control, but the migration from the edges of the dome could be held back, or at least allowed to encroach only as the oil was produced, by suitable pressure control. The second factor was the apparent certainty that with normal production, and subsequent additional lowering of the already low formation pressure, reservoir pressure differentials would result in swift encroachment of edge-water that would trap large volumes of oil in the loose sand-body.

As most of the wells had been drilled on a 10-acre plan, the block could not be developed with gas injection as a prime influence. In view of the desired control over formation-water, no strict adherence to a uniform spacing for injection wells was made. Instead, the injection wells, some old producers and some new wells for that purpose, were selected on the basis of their adequacy. This was judged on the degree of encroachment in a particular area, the oil present, reservoir energy locally available,

water–oil ratio, and the thickness of the pay at the spot. On such basis a plat would indicate somehat haphazard spotting of the injection wells, and not the more practical operating balance obtained by adjusting their location to meet reservoir conditions. The compressor plant, distribution system, and gas manifolds are described.

A.P.I. gravity of the oil showed an increase, as well as the production recovery.

A. H. N.

372.* Sampling Distillate Wells. K. E. Cody and D. M. Luntz. *Oil Wkly*, 17.2.41, **100** (11), 17–18.—One of the satisfactory methods of obtaining an accurate analysis of the raw well-gas is to flow the stream into a high-pressure separator, collecting and analysing samples of the separator vapour and liquid. A diagram and typical calculations illustrate the method. By compositing these two analyses according to a material balance on the separator, the analysis of the raw gas is obtained. This method of procedure naturally requires the metering of both the dry gas and the liquid.

It is possible in most instances to take a representative sample of the raw gas directly from the well-head before the choke. However, such a sample is very difficult to handle in the laboratory, and this method will not give enough distillate for a complete evaluation unless the sample is continually drawn into a small separator and the gas and liquid are measured and handled as described above. The latter method is generally used in connection with portable testing units.

Samples of raw well-gas should never be taken from the line between the choke and the separator, as the throttling effect of the choke changes the gas from a substantially homogeneous mixture into a liquid–vapour mixture. Sampling such a system is extremely difficult, if not impossible.

To illustrate the information which should be available in a complete distillate evaluation, a specific work-sheet is presented, with explanations of the various operations and results.

A. H. N.

373.* Re-working Wells. E. S. Post. *Oil Wkly*, 17.2.41, **100** (11), 34.—Re-working in South Texas fields has been found to pay dividends. An almost set practice is followed. A portable spudder type of rig is moved over the location and rods, tubing, and remainder of the pumping unit are removed from the hole. The liner also is fished out and the well bailed down dry as possible. A sand-pump type of bailing unit is used to remove all sand, shale, sediment, etc., from the hole. If there is an excessive amount of gas, the hole is filled with clean oil and the sand-pump is worked at the bottom of the fluid load. No water is put in the hole at any time, as the shale and bentonite content in the formation expands rapidly, thus requiring a greater amount of bailing to finally clear the formation.

A. H. N.

374.* Acid-Soluble Cement as an Aid in Increasing Flow Through Gum-Perforations. W. A. Sawdon. *Petrol. Engr*, January 1941, **12** (4), 33–35.—The acid-soluble cement is made by mixing approximately equal parts of any type of oil-well or Portland cement with a specially prepared calcium carbonate. The latter chemical differs considerably from that now being used for conditioning mud-fluid prior to acid treatment for removal of the mud-sheath from the wall of a producing sand.

Although evidence is still lacking on which to base definite requirements concerning the strength of cement for different oil-well jobs, a reduction in shrinkage is always desirable, as excess shrinkage may not only cause cracking, but will tend to weaken the bond between the cement encasement and the wall of the hole. The shattering of the cement around the pipe by the action of the tools going in and out of the hole is believed by some engineers to be a frequent occurrence, particularly when the clearance is small; it is asserted that tests have indicated the acid-soluble cement to show less shatter than neat cement.

Another factor that may have an influence on the success of a cement job is the scouring effect on the walls of the hole that probably accompanies the abrasive action caused by the calcium carbonate in the slurry.

The quantity of set cement that can be dissolved with any unit volume of acid is fixed, and depends on the area of contact of the acid and the cement. The amount of cement dissolved is therefore less when the area of contact is small than when the area of contact is large, and as the acid spends itself a protective coating is formed

on the cement that inhibits further action. When acidizing via a hole through this cement there is thus no danger of the action of the acid extending to a point where the effectiveness of the cement as a water shut-off will be impaired.

Procedures of utilizing this cement, as well as test data on its properties, are given and illustrated graphically. A. H. N.

375.* **Practical Application of Planned Optimum Rate Proration. Pt. 2.** A. M. Crowell. *Petrol Engr*, January 1941, **12** (4), 54.—Following the discovery of a new pool, reservoir pressure tests are conducted on representative wells by the engineers as development proceeds. These key wells are selected for their structural position, and must be so spaced that the areally weighted reservoir pressure obtained will be representative for the pool as a whole. Once selected, these same wells remain as key wells during the life of the pool. After a shut-in period of not less than 24 hr., each well of the key-well group is tested at regular intervals with standard subsurface pressure gauges.

The bottom-hole pressures obtained are then posted on a map at the points representing the well locations; the map is contoured in 50-lb. intervals and planimetered so that the areally weighted reservoir pressure may be arrived at. The individual pressures of the wells not tested are read from the map by interpolation.

Briefly, changes in reservoir pressure and in gas–oil ratio determine the production quota fixed for any pool for a given period. If, in a water-drive pool, a decline in reservoir pressure is registered for two consecutive periods, the quota for that pool is restricted until the pressure decline is arrested.

In the case of a gas-drive pool where pressure decline is a normal function of withdrawal of oil and gas, an abnormal acceleration of decline may result in the commission further restricting gas–oil ratio allowances.

Very soon in each oil pool the most efficient rate of production can be determined within 10% or 15% of the optimum. As soon as this rate is determined, a top allowable is set, subject only to minor adjustment as additional units are brought into production.

Under this system of fixing optimum rates of production, market demand plays only a secondary rôle. Inasmuch as the inefficient or unnecessary storing of oil is prohibited, it is impossible to exceed the bona-fide market requirements for oil from the fields under control without violating the law.

The paper is detailed in treatment and is concluded with an appendix regarding the Oil and Gas Conservation Law for Arkansas. A. H. N.

376.* **Use of Electric Power Increases in all Phases of Petroleum Industry.** H. E. Dralle. *Petrol. Engr*, January 1941, **12** (4), 72.—Electric drive has proved particularly suitable for providing increased power for drilling because of its flexibility. For maximum performance there is a noticeable trend towards the direct-current variable-voltage system of control. It is mobile, self-contained, and flexible, and on many large rigs the generators are designed to prevent stalling the engine under any operating conditions. By adding suitable units for parallel operation as well as capacity to the draw-works motor, it is practicable to obtain any amount of power for hoisting within the mechanical capacity of the rig. The best practice seems to dictate the use of 1 kw. of generator capacity for each h.p. of motors connected, for any operation.

In oil production using electrified drives there is a definite trend to automatic pumping by time-switch control. This is used not only on wells of small volume requiring occasional operation, but also on wells that are pumped intermittently in compliance with proration schedules.

Time switches can be preset to start and stop wells on any cycle from once each 24 hr. to once each quarter of an hour. Many pumping units now employ a weather-proof motor and control of the type that utilizes time-switch operation, and high-torque motors ensure oil-well starting even under adverse weather and well conditions.

When central station power is not available a popular method of obtaining electric power is from a self-contained, engine-driven, power unit.

The paper further deals briefly with the use of electric power in refineries, recycling plants and pipe-lines cathodic protection. A. H. N.

377.* Electric Power Provides for Flexible Expansion as Well-Pumping Needs Increase. H. L. Flood. *Petrol. Engr*, January 1941, **12** (4), 27–28.—The factor of flexibility requirement is recognized as being especially important in the East Texas field because of the erratic performance of wells, even when side by side and producing from virtually the same depths in the woodbine sand. On the same lease being discussed, two wells now pumping may be separated by another well still flowing—all producing from the same depth. It was this factor of flexibility that largely dictated to the companies operating in East Texas the use of electric central plants. Although motors have been installed having capacity to serve the increasing power requirements of the wells for some time to come, and consequently are in all instances larger than the wells in their present condition require, full benefit is derived from the ability to combine all the smaller individual current consumptions of the several wells. This permits satisfactory operation with much less installed horse-power in the generating plant than would be possible if, say, individual engines were installed at each well having the same provision for future needs of the wells.

The generators, distribution system, and individual well equipment are briefly described. One of the advantages of electric power for pumping that is welcomed by the production engineer responsible for maintaining efficiency of the producing units is the facility with which the well can be accurately studied and its operation judged. The simplest manner by which this may be done is to use an indicating ammeter to observe the amount of current consumed at various phases of the pumping cycle. If recording instruments can be made available, a " card " should be obtained that will divulge information concerning the well as accurately as other forms of dynamometers.

A. H. N.

378.* Conservation and Economics of Gas-Condensate Fields. J. O. Lewis. *Petrol. Engr*, February 1941, **12** (5), 51.—The method of operating a gas-condensate property is to produce the gas, pipe it to an extraction plant, extract the fluids, recompress the gas, and inject it underground, preferably into the same sand. The extraction plant may be simply a system of gas separators and coolers with a stabilizing unit that will extract some 80% of the liquids, or it may be an expensive refrigeration or absorption plant that will recover more than 95% of the liquids, even the butanes. The investment consists of the cost of discovering the field and acquiring the land, the cost of wells, the cost of the extraction plant and the cost of the compressor plant. The parts are inseparable, and the output must pay a return not only on the property and the wells, as does an oil property, but also on the plant and the expenses of operating it. The wells are costly, for gas-condensate fields are found in deep sands.

Because the condensates exist underground as vapours, often in concentration of less than 1 gall./M cu. ft. of gas, the condensates contained in an acre of sand are much smaller in volume than the oil in an oil-sand of equal thickness, area, and porosity. If it were necessary to drill wells to the spacings customary in oil-fields, it would not be profitable to develop a condensate field, and it would remain a frozen asset; but gas moves much more readily through a sand than does oil, consequently the wells can be spaced much farther apart. The percentage of condensate recoverable in a moderately uniform sand will be little influenced by the number of wells, but rather by their structural positions and geometric pattern. Spacings of as much as 300 acres/well have been used, and even wider spacings could have been used, were it not necessary to provide a sufficient number of outlets so that the gas may be extracted at legal rates within a reasonable period of time.

Operations in Texas and economics of cycling are discussed. A. H. N.

379.* Problems in Condensate-Type Production. R. L. Huntington and C. Schmidt. *Petrol. Engr*, February 1941, **12** (5), 68.—Production practice and principles of keeping the fluids in a single vapour phase in condensate fields are briefly reviewed.

The drilling of wells on 10-acre tracts would be entirely out of the question in most distillate fields. In the first place, the total value of recoverable condensate would probably not equal the first cost of such intensive development. Furthermore, the effective drainage of widespread acreage will take place in single-phase fluid or condensate fields in much the same manner as in gas-fields. Although two wells (one for cycling and pressure maintenance, and the other for withdrawal of condensate-

bearing fluid) might eventually produce substantially all the condensate from a lease several square miles in area, it is unlikely that the time rate of pay-out would be fast enough to attract investors into such a proposition. It is more probable that the spacings will be of the order of 80–320 acres, depending on the allowables and the fluid content of the particular reservoir in question.

Recovery processes are very briefly described. Data from experiments on the mixing of gases in such fields show that the mixing rate is an inverse function of pressure.

A. H. N.

380.* Testing Condensate-Type Wells. G. O. Kimmell. *Petrol. Engr*, February 1941, **12** (5), 76.—As tapped, most condensate-type reservoirs are in a state of "saturation" or at their "dew-point." Three distinct types are known: (*a*) reservoirs at their dew-point isolated from any associated oil, (*b*) "under-saturated" reservoirs isolated from any associated oil, and (*c*) saturated or dew-point reservoirs (or gas-caps) overlying an oil-saturated zone.

There is a fourth type of reservoir producing through "dry gas wells" that would exhibit retrograde phenomena were the gas subject to proper temperatures and pressures never encountered in normal production. Graphs show the effects of pressure and temperatures on each type.

Condensate well characteristics are discussed. The pressure rise in a condensate well reaches a maximum, after which it declines. Two factors control the shape of pressure build-up curves: (1) ability of the reservoir pressure to "neutralize" the resistance between the reservoir and well-head, and (2) the physical changes along the resistance after shut-in. The pressure-rise part of the curve is controlled by (1), and the pressure-decline part by (2). The controlling physical change is that of increased density of the vapours in the conductor as it cools off. Pressure build-up curves will tend to coincide after a time, provided the reservoir pressure is not reduced during the period over which the data are compared.

Methods of sampling are described in some detail, and these are followed by procedure for analysing the samples.

Preliminary tests have proved that it is possible to develop small-scale equipment for all the following types of investigations: (1) direct measurement of reservoir conditions that would provide data for the development of the useful parts of the "pressure–temperature-phase" diagram. (2) Examination at extremely high pressures of the effects of counter and concurrent absorption on extraction efficiency, and examination of various absorption mediums. (3) Low-temperature, high-pressure studies. (4) Thermodynamic properties such as specific heats, Joule–Thomson effects, and film coefficients.

A. H. N.

381.* Well-Completion Methods in Condensate Fields. Anon. *Petrol. Engr*, February 1941, **12** (5), 94.—One of the most important considerations in completing either a producing or injection well is to provide a clean, unobstructed formation face opposite the section of casing that is opened or perforated. Uncased hole is not considered advisable in wells that are to be used for the injection of gas, on account of possible caving and sloughing-off.

The cleaning of injection wells may be accomplished in three ways. The method to be used depends largely on the conditions existing. The first and simplest method is to back-flow a well at a rather rapid rate for a short interval. The high velocity of gas leaving the face of the formation imparts a beneficial cleaning action.

The second method is to wash the well with clear water, then unload and back-flow. This method will often remove mud filter-cake that otherwise plasters the sand-face.

The third and most effective method is to give the wells a treatment of mud acid. The acid is pumped into the well, allowed to stand the proper time, and the well then back-flowed. This type of treatment has been used in deep high-pressure operations with much success. Wells treated have nearly doubled their intake capacities and the working pressures required have been greatly reduced.

To reduce capital investment, dual and triple completions are fast becoming standard practice in multiple-zoned pools. Dual and triple completions are in general use in California and Illinois. Dual completions are used in Texas and Louisiana and on a few installations in Kansas. Details of these are given.

A. H. N.

382.* Physical Properties of Hydrocarbon Mixtures in Condensate Production. F. H. Dotterweich. *Petrol. Engr*, February 1941, **12** (5), 98.—A study on binary mixtures with components of complete mutual solubility, in all proportions, produces complicated results when investigated. In addition to variations in temperature, volume, and pressure, a fourth variable is encountered—that of composition. Phase relationships are explained with the aid of diagrams giving the effects of variations in three of these four variables on the fourth.

To illustrate retrograde condensation examples are given, one of which is the following: when a mixture is tested at 35° C., the liquid phase appears at a pressure of 43 atm. (630 lb./sq. in.). As the pressure increases the liquid will increase to a certain point, after which this procedure is reversed and the liquid phase decreases until at a pressure of 93·5 atm. (1375 lb./sq. in.) it completely disappears and only the gaseous phase appears. This experiment at 35° C. and varying pressures on such a hydrocarbon mixture illustrates the phenomena of retrograde vaporization of the first type. Should the experiment be repeated at 35° C. but beginning with a pressure greater than 93·5 atm., only the vapour phase would be present. Should the pressure be dropped to 93·5 atm., the liquid phase would appear and increase with lower pressure in the retrograde range, and this procedure may be referred to as retrograde condensation of the first type. Other types of retrograde systems are similarly detailed.

Graphs of equilibrium vaporization constants for gas mixtures are given and their significance is detailed.

Single- and multiple-stage separation are discussed. An interesting point noticed is that at higher pressures it is found that the volume of liquid becomes more nearly the same for different temperatures of separation. In addition, with single-stage separation at pressures higher than 2500 lb./sq. in., it is possible to obtain greater recoveries at higher temperatures or, in other words, there is a retrograde temperature effect.

A. H. N.

383. Patents on Production. T. W. Murray. U.S.P. 2,229,115, 21.1.41. Appl. 24.6.39. Pumping and drilling unit comprising a motor, a driven shaft, variable-speed and reduction gearing, a crank-arm at each end of the shaft and flexible means driven by the crank arms for operating the pumping rods.

H. T. Kennedy and A. J. Teplitz. U.S.P. 2,229,177, 21.1.41. Appl. 26.5.39. Water shut-off in oil- and gas-wells by means of plugging material the action of which is inhibited in the pay-zone but allowed to proceed in an adjoining water-sand.

H. H. Greene. U.S.P. 2,229,325, 21.1.41. Appl. 3.8.40. Deep-well bridge.

J. A. Pate and C. L. Pate. U.S.P. 2,229,519, 21.1.41. Appl. 2.8.37. Releasing pump-plunger.

J. A. Zublin. U.S.P. 2,229,538, 21.1.41. Appl. 1.5.39. Method of producing oil and gas from a well consisting of agitating and releasing gas from the oil, driving back the gas to an oil formation and producing the oil.

J. A. Zublin. U.S.P. 2,229,539, 21.1.41. Appl. 1.5.39. Method of and apparatus for producing oil and gas from a well whereby the gas and oil mixture is compressed before the gas is released for reinjection in the formation.

J. A. Zublin. U.S.P. 2,229,540, 21.1.41. Appl. 1.5.39. Method of repressuring oil- and gas-wells.

J. A. Zublin. U.S.P. 2,229,541, 21.1.41. Appl. 12.5.39. Apparatus for pumping oil-wells containing agitating means to separate the gas from the oil and pump the separated oil to the surface.

H. L. McLaughlin. U.S.P. 2,229,581, 21.1.41. Appl. 15.10.37. Well-shooting bridge.

M. T. Works. U.S.P. 2,230,421, 4.2.41. Appl. 7.6.38. Pipe hanger for a well-head.

D. L. Katz. U.S.P. 2,230,619, 4.2.41. Appl. 18.3.35. Process for separating gas and oil issuing from an oil-well so that the gas will be dry and the oil will contain all the gasoline constituents originally present in the crude.

G. Swain. U.S.P. 2,230,787, 4.2.41. Appl. 4.6.35. Fluid-actuated pump.

C. J. Coberly. U.S.P. 2,230,830, 4.2.41. Appl. 5.3.35. Deep-well pump and method of installing and removing the same.

V. L. Andrew. U.S.P. 2,230,856, 4.2.41. Appl. 10.12.38. Pitless pump adapted to be fixed in a well-casing.

H. M. Loeber. U.S.P. 2,231,131, 11.2.41. Appl. 14.6.37. Deep-well pump.

L. L. Rector. U.S.P. 2,231,221, 11.2.41. Appl. 1.6.37. Packing device.

J. P. Sullivan. U.S.P. 2,231,303, 11.2.41. Appl. 30.3.39. Pump.

A. W. Steenbergh. U.S.P. 2,231,417, 11.2.41. Appl. 11.2.41. Intermittent gas-lift control with a spring-controlled valve and an impact means actuated by the flow of the liquid to open the valve.

M. L. Johnston. U.S.P. 2,231,425, 11.2.41. Appl. 14.7.39. Oil-well testing device for testing formations.

M. De Groote. U.S.P. 2,231,752 and 2,231,753, 11.2.41. Appl. 20.2.39 (both). Processes for resolving petroleum emulsions by means of water-insoluble salts of basic alkylamines.

M. De Groote. U.S.P. 2,231,754, 2,231,755, and 2,231,756, 11.2.41. Appl. 13.7.39 (all three). Processes for resolving petroleum emulsions of the water-in-oil types.

M. De Groote. U.S.P. 2,231,757, 11.2.41. Appl. 23.10.39. Process for resolving petroleum emulsions of the water-in-oil type.

M. De Groote. U.S.P. 2,231,758 and 2,231,759, 11.2.41. Appl. 26.1.40 (both) Processes for resolving petroleum emulsions of the water-in-oil type.

R. T. Smoot. U.S.P. 2,231,820, 11.2.41. Appl. 30.3.40. Pump.

E. T. Adams. U.S.P. 2,231,861, 18.2.41. Appl. 27.9.38. Well-pump.

W. L. Bald. U.S.P. 2,232,199, 18.2.41. Appl. 25.1.40. Hydraulic oil-well packer.

J. M. Hamilton. U.S.P. 2,232,325, 18.2.41. Appl. 18.5.40. Well-packer.

O. F. Ritzmann. U.S.P. 2,232,476, 18.2.41. Appl. 27.11.39. Method and apparatus for measuring depths in wells by means of high-frequency explosive sounds.

See also Abstract No. 341. A. H. N.

Transport and Storage.

384.* Cathodic Protection of Oil Storage Tank Bottoms. D. H. Bond. *Petrol. Engr*, March 1940, **11** (6), 100–102.—Normally cathodic protection is thought of as applying to pipe-lines, and when extending the method to cover tank bottoms the relatively large area to be protected must be borne in mind. An 80,000-barrel tank with 10,700 square feet of base is equivalent to 6171 ft. of 6-in. pipe.

Once the D.C. amperage for complete protection has been decided on, the type of equipment to be used must be chosen so as to take into account the various contradictory effects. For ground beds of given resistance the larger the number of units installed the less will be the power required to give the total amps. Further, better current distribution will be provided, thereby reducing the amount of ground-bed

cable required. Against this there is the increase in cost of installation as more units are used and higher maintenance costs. Similarly the choice of generators or rectifiers for the production of the D.C. current will depend on the type of power and labour available.

In a given case, satisfactory protection was afforded to a Gulf Coast tank-farm containing forty-five 55,000-barrel tanks, that had suffered serious corrosion in the past, by the installation of 4 units with a rating of 15 v. and 100 amps. each. These units were motor generators driven by 220-v. 3-phase electrical power available at the farm. The ground-bed resistances varied from 0·122 to 0·208 ohms, and consisted of lengths of 8-in. pipe buried horizontally, together with lengths of 6-in. pipe buried vertically.

From the estimated cost of this installation it was apparent that a considerable annual saving would be made—in fact, the elimination of reconditioning each tank at 10-year intervals would pay for the installation in one year.

Assuming that the potential of the protected surface must be at least 0·80 v. negative to ground, all the tanks except one were fully protected, as were all connecting pipes and coated incoming and outgoing trunk-lines for 1½ miles from the property.

T. T. D.

385.* Protective Coating on Above-ground Pipe-Line Structures. C. F. Rassweiler. *Petrol. Engr*, March 1940, 183–186.—In the painting of storage tanks, protection from corrosion at minimum cost is no longer the primary consideration. The controlling factor is now the necessity of reducing evaporation losses by using paints of high reflectivity. In choosing these, average light reflection is of more importance than the initial value, but, especially in the case of tank whites designed to disintegrate by gradual surface erosion, the factors of annual maintenance cost and length of protective life are still important considerations. Proper preparation of the surface by adequate metal cleaning, and selection of a primer, which not only has a good inhibitive effect but also has good durability when exposed by the eroding top-coat, will ensure that repainting will only become necessary when the top-coat has chalked thin enough to affect appreciably light reflectivity or appearance.

If the paint is to withstand such exposure to water and chemicals that the use of special materials is justified, recourse may be had to: (1) bituminous finishes, (2) the alkyds, (3) the phenol formaldehydes, (4) the chlorinated rubbers. Type (1) have outstanding resistance to water and chemicals, but poor durability to normal weathering. They are most effective when applied in thick, hot coatings, but these have a poor appearance. Type (2) have the best properties when normal weathering is the important factor and exposure to water is intermittent and strong chemicals are absent. Type (3) have outstanding resistance to water or mild chemicals, especially mild acids, but not to strong alkali. Their most effective use is totally submerged or where normal weathering is less important than other effects. Type (4) are inert to water or relatively strong acids or alkalis. In a moist atmosphere, however, their use is of questionable value above 150° F. They are the most expensive per unit of film thickness and, owing to their high viscosity, difficult to apply. They are most useful under conditions too severe chemically for the phenolic finishes.

Especially on areas exposed to water and chemicals, great attention must be paid to cleaning the surface of the metal. Unless rust and chemicals are thoroughly removed, it must be realized that painting will merely improve the appearance and have relatively little value in preventing corrosion. Particular attention must also be paid to application on these areas, which are liable to be badly roughened, and care must be taken to see that an adequate thickness of paint is piled up over the rough sections. It is also vitally important that the surfaces involved should be kept clean and free from water and chemical spray during the period of cleaning and priming, the application of subsequent coats, and until the finish has had adequate time to harden.

In the painting of galvanized-iron surfaces, modern practice is not to allow preliminary weathering; when repainting is done, the same cleaning precautions should be followed as are ordinarily specified for steel. The painting is obviously useless unless materials are used that will adhere permanently to the zinc surface. Primers of this type are now available, containing zinc dust incorporated in a special vehicle. It has been shown that water-soluble soaps tend to form at the zinc-paint interface and, aided by moisture coming through the paint film, destroy adhesions of the paint

coatings. The zinc dust in the primer presumably causes these zinc soaps to form in the primer itself rather than at the interface, so that adhesion is not affected.

T. T. D.

386. Modern Practices in the Protection of Pipe-Lines against Corrosion. S. Thayer. *Petrol. Engr*, Midyear 1940, **11** (10), 131–133.—The author describes various methods which are now in use to minimize pipe-line corrosion.

Construction of New Lines.—(1) A careful soil survey is made to determine the coating procedure. The pipe-line is then entirely coated except where it passes through soil known to be definitely non-corrosive. The success of this method depends on the care and experience of the soil examiners.

(2) New lines are entirely coated. This is probably a somewhat wasteful method, but eliminates the difficulty of knowing with certainty which soils will give trouble.

(3) Lines are laid unprotected and "hot-spots" which develop later are replaced by new coated line. This may prove expensive, especially if the "hot-spots" are numerous or extensive in area, but in many cases will be less than the cost of coating the entire line.

(4) Lines are laid bare and either the "hot-spots" protected electrically as they develop, or the entire line is so protected. In the author's opinion it is bad practice to lay a bare line and then install electrical protection, as the cost would be considerably more than the cost of coating plus the cost of equipment to protect a well-coated line.

(5) In a few cases the lines are well coated and electrical protection installed immediately. Any faults in coating that may occur will then be protected. If the coat is highly resistant and the faults not too large in area, a very small current is required for protection, one small unit being sufficient to protect at least 5 miles. This method should prove extremely efficient.

Maintenance of Old Lines.—(1) Affected line, as determined by frequency of leaks, is replaced by new or reconditioned pipe, generally coated. Care must be taken that the replacement extends well beyond the affected area. This method is liable to be expensive.

(2) Electrical protection is installed as necessary to cover affected areas. This has proved an excellent method, although obviously not practicable for very small pipe-lines where the affected areas are only a few feet in length.

(3) Instead of waiting for the occurrence of leaks, surveys are made to determine where the pipe is most affected. Several methods for making these surveys are in use, all depending to a greater or lesser extent on the skill of the examiner. They include tracing the electrical currents on the pipe to the points of discharge into the soil, analysis of the soil to determine suspected areas, and examination of the pipe where, in the opinion of the examiner, the poorest pipe is likely to be found. From the results of these surveys, the steps necessary for suitable protection must then be decided.

(4) Electrical protection is installed, where convenient and inexpensive, regardless of the state of the pipe. Units are installed at booster stations and the protection forced to extend as far as possible in both directions. This method has proved to be almost ideal in a particular case, but is probably not so easily adaptable to other systems.

The remainder of the article was devoted to a comparison of the merits of various types of units used for electrical protection including rectifiers, motor generators, windmills and engines.

T. T. D.

Crude Petroleum.

387. Analyses of some Illinois Crude Oils. H. M. Smith. U.S. Bur. Mines. Report of Investigations No. 3532, December 1940.—By virtue of important discoveries of new oil-fields made in 1937, Illinois is now one of the most prolific oil-producing areas in the United States. This report embodies the results of analyses of thirty-five samples of petroleum from these new fields, and also includes analyses of seven samples from fields developed before 1936. The samples analysed represent three geographically different producing areas in the State—namely, the eastern boundary in Clark, Crawford, Lawrence, Edwards, Wabash, White, and Gallatin Counties; an area

25 miles farther west in Clay, Richland, and Wayne Counties and the north-western corner of White County; and the south-central area in Fayette, Marion, Clinton, Washington, and Jefferson Counties.

Of the forty-two samples analysed only four show marked deviations from the general average, the others being similar to Oklahoma City crude oil, except that they are slightly more naphthenic and have a somewhat higher sulphur content.

Included in the report is a table listing the samples in order of increasing sulphur content, and from this it becomes apparent that most of the high-sulphur oils are found in the group of fields along the eastern border of the State and, further, that no low-sulphur oils are found in that area. In fact, if a division is made between those having less than 0·18% sulphur and those having 0·18% or more sulphur, none of the samples from the eastern area will fall into the first group. Similarly all the samples from the area farther west in Wayne, Richland and Clay Counties will fall in the second group, and only six of the remaining samples from the south-central area will fall in the second group.

The question is raised as to whether a more extended survey of Illinois crude oils would corroborate this apparent segregation of high-sulphur oils. H. B. M.

388.* Talco-Treating Methods Provide Fuel Economy and More Settling Time. G. Weber. *Oil Gas J.*, 10.3.40, **39** (21), 34.—A description is given of various methods of water removal from the heavy asphaltic Talco crude. The particular problem in this field is the lack of gas, necessitating the purchase of fuel gas for the treating of the crude. In general, the maximum amount of water is separated by settling, and chemical treatment using 1 qt. to 25 qts. for 1000 brl. oil is then carried out at 120–130° F. Hay-tanks consisting of baffles, excelsior section, and heaters are still used in the field, in addition to more modern methods. Heat conservation is effected by preheating in stack and return stream exchanges, utilization of non-condensible vent-gases from flumes and lease tanks, and utilization of heat in exhaust gases of pumping engines. C. L. G.

Cracking.

389.* Improved Processes in Manufacture of Motor Fuels from Petroleum. G. Egloff. *Petrol. Engr*, Midyear 1940, **11** (10), 21–26.—The primary function of cracking is to increase the quantity and improve the quality of the gasoline that can be obtained from a crude. The success of this process may be gauged from the fact that, on cracking, an average yield of 45% is obtained from crude, compared with 21% straight-run. Further, an average octane number for cracked gasoline is 70, whereas straight-runs are sometimes as low as 15.

In the case of thermal cracking, at temperatures of 900–1100° F. and 1000 lb./sq. in. pressure, octane numbers average about 70 from charge stocks of gasoline, naphthas, or heavy oils. To produce gasolines of higher octane number, catalytic cracking is available. Catalytic reforming of gasoline or naphthas at 950° F., and low pressure, may yield upwards of 80% of 80-octane-number gasoline. The gases obtained as by-products are much richer in olefines than those obtained from thermal cracking. These gases are converted into high-octane fuels either at high temperatures and pressures, or catalytically in the presence of phosphoric acid at low temperature and pressure. In this way the butane–butene fraction is catalytically polymerized to yield *iso*-octenes, which are hydrogenated to *iso*-octanes.

iso-Octane is also manufactured by catalytic alkylation, adding butene to *iso*-butane at 0–30° C. in the presence of 90–100% sulphuric acid. *neo*-Hexane, however, is best prepared by thermal alkylation, using *iso*butane and ethene as charging stocks.

Another catalytic process of great importance is isomerization, especially of butane to *iso*butane for use in the preparation of *iso*-octanes, but also generally of *n*- to *iso*paraffins.

The development of catalytic dehydrogenation of gaseous paraffins to olefines and hydrogen gives an immense source of raw materials for the synthesis of chemical derivatives, including synthetic rubber. By catalytic cyclization of the lower-boiling members of paraffinic crudes, a new source of aromatics is available for the explosives industry.

Summarizing, the author concludes that, from its petroleum sources, the U.S.A. is more than self-supporting in gasolines up to and surpassing 100 octane number; it could produce billions of pounds of explosives, and it could be more than self-supporting in synthetic rubber. T. T. D.

390.* High Gasoline Yield by Polyform Process. P. Ostergaard and E. R. Smoley. *Oil Gas J.*, 2.9.40, **39** (18), 52.—The basic principles of the polyform process and operating data based on five plants in operation are discussed in detail. The polyform process consists of processing a cracking stock mixed with gaseous hydrocarbons at higher temperatures and at a higher degree of conversion per pass than is possible under normal cracking conditions, without excessive coke formation. Polymerization and other side reactions increase the yield and give more valuable products.

In normal cracking below the critical temperature of the oil a film of the latter forms on the furnace tubes, preventing the stock being cracked to a more severe degree than if the oil alone were present. The introduction of sufficient gaseous hydrocarbons increases the critical temperature of the mixture to that at which the oil can be cracked by itself. At this point the film on the tube wall is of the same composition as the main body of hydrocarbon vapour passing through the tube. From a knowledge of the properties of the cracking stock the optimum quantities of C_3 and C_4 hydrocarbons which must be recycled through the coils can be calculated.

East Venezuelan naphtha, West Texas gasoline, and a 50/50 blend of M.C. and Pa. gasoline gave yields on polyforming in a simple once through unit of 77–84% of cracked distillate which when stabilized had an O.N. of 75–76. Typical operating conditions were: back pressure on heating element 1000–1500 lb. per sq. in., tower pressure 300–400 lb., and outlet temperature from heater 1020–1125° F.

Two polyform units are equipped with coking drums which handle the polyformed residue, utilizing the waste heat in the furnace discharge, producing in addition gasoline and gas oil suitable for thermal cracking.

A two-coil and a four-coil combination crude polyform unit are in operation, the latter producing from crude oil only straight-run gasoline, polyformed distillate, C grade fuel oil and dry gas.

In naphtha polyforming it is always possible to produce a 75–77 O.N. gasoline from any stock, the spread between A.S.T.M. Research O.N. being 9–14, as compared with 5–9 for thermal-cracked gasoline. The road octane numbers also show a higher appreciation. Blending value is high (87–110), and lead susceptibility similar to that of thermally cracked gasolines. Treating presents no difficulties, inhibiting only being necessary for incorporation into coloured blends and clay treatment for production of water-white blends. By modifying conditions, a distillate of 80–84 O.N. can be produced, which on acid treatment gives aviation of 77–79 O.N. requiring less than 3 c.c. lead to give 90 O.N., and an 80 O.N. aviation safety fuel. Such distillates contain high percentages of toluene and xylene, which can be concentrated by distillation. C. L. G.

Hydrogenation.

391.* Destructive Hydrogenation Improves Product from Inferior Hydrocarbons. R. Fussteig. *Petrol. Engr*, March 1940, 56–62.—In the petroleum industry, hydrogenation implies destructive hydrogenation, with the intention of increasing the yield of high-grade gasoline from crude. It is thus pyrolysis followed immediately by addition of hydrogen. Hence the free radicals formed when the charge stock is decomposed are stabilized instead of being allowed to interact and form unwanted polymers of low H-content such as coke and tars.

In order to obtain the best yield of gasoline, the most suitable catalyst must be used in both cracking and hydrogenation processes, the first to increase cracking velocity so that the formation of gaseous hydrocarbons is at a minimum, the second to bring about hydrogenation before polymerization can take place.

Early research was hindered through the poisoning of catalysts by the hetero-elements present in petroleum, and even with the modern non-poisonable types difficulties are still encountered. For instance, with heavy oils, except at low throughput and partial pressure of products, the catalyst tends to be inactivated by the charge

stock itself. To obviate this difficulty, the process is divided into two stages, liquid phase and vapour phase, each with its appropriate catalyst. In the first process higher molecular-weight hydrocarbons are split and hydrogenated to middle molecular-weight hydrocarbons, which, in turn, are split and hydrogenated in the vapour-phase process. In the hydrogenation of coal or charcoal a three-stage process must be employed for maximum efficiency: first the oil–coal paste is hydrogenated in the "liquid" phase to produce a heavy oil, which is once more hydrogenated in the liquid phase and finally in the vapour phase.

Besides the true destructive hydrogenation processes, there are in existence combined hydrogen-addition-cracking systems which differ in that simultaneous decomposition and hydrogenation take place in the former, whereas in the latter the hydrogenation takes place after the rearrangement of the hydrocarbon vapour.

The author concludes with descriptions of the flow-sheets of three existing hydrogenation plants, two using heavy oils as charge stock, and the third coal.

T. T. D.

392. Patent on Hydrogenation. H. B. Kipper. U.S.P. 2,224,603, 10.12.40. Appl. 17.8.39. Dehydrogenation and oxidation of petroleum oils to produce so-called drying oils. The oils are selectively oxidized under agitation with nitric acid in the presence of an oxide of a metallic element, as a catalytic material. Thereafter the oxidized oils are condensed with resins in the presence of so-called solid phosphoric acid.

H. B. M.

Polymerization and Alkylation.

393. Patents on Polymerization and Alkylation. P. H. Sykes. E.P. 530,642, 17.12.40. Appl. 16.6.39. Process for the production of solid polymers of *iso*butylene by passing *iso*butane over a dehydrogenating catalyst, cooling the resulting gases to condense liquid *iso*butylene and any unchanged *iso*butane, and polymerizing the *iso*butylene in the liquid condensate, in the presence of an inorganic halide polymerizing catalyst at a temperature below −7° C.

Les Usines de Melle. E.P. 532,158, 17.1.41. Appl. 16.9.38. Catalytic polymerization of diolefines in which a peroxide of tetrohydrofurfurane, or its homologues, is used as a catalyst.

Universal Oil Products Company. E.P. 532,381, 23.1.41. Appl. 19.5.39. Catalytic polymerization of normally gaseous olefinic hydrocarbons consisting substantially of propylene and/or butylenes to form olefinic polymers of gasolene boiling range.

Anglo-Iranian Oil Co., E.P. 532,864, 3.2.41. Appl. 26.4.39. Continuous process for the alkylation of *iso*butane or *iso*pentane by condensation with one or more of the reactive olefines specified. The catalytic contact agent and the *iso*paraffin are together circulated in a stream in a number of successive reaction stages at a rate in considerable excess of the rate of addition of the olefin to the stream, and at a considerably higher rate than the proportional feed rates of *iso*paraffin to total olefine to the stream. Thus under the intensive conditions of turbulence of the stream a low maximum content of olefine is maintained in the stream in the course of the reaction in the stages.

A. L. Blount. U.S.P. 2,225,544, 17.12.40. Appl. 14.5.38. Process for the manufacture of alkylated *iso*paraffinic hydrocarbons. *iso*Paraffinic hydrocarbons having less than 7 carbon atoms per molecule are reacted with olefinic hydrocarbons having more than 2 carbon atoms per molecule, in the presence of a catalyst containing strong sulphuric acid, a dehydrating agent, other than the alkylating catalyst, which is compatible with the said catalyst.

H. B. M.

Refining and Refinery Plant.

394.* Progress in Refining of Crude Petroleum. A. L. Foster. *Petrol. Engr*, Midyear 1940, **11** (10), 28–34.—Trends of refining progress in 1939 have been in the direction of increased specialization in personnel, process, and product. The first is shown

by the much greater use of technical graduates not only in the research and development departments, but also in the operating and maintenance divisions. This trend can also be seen in the wider use of pilot plants and semi-plant scale units designed to bridge the gap between test-tube scale laboratory operations and the full-scale operation of the commercial plant that must be economically profitable.

In the field of process development the control of plant processing in the light of product requirements was particularly outstanding in 1939. More than ever, the processes used by the refiner determine the properties the product will exhibit, and bearing in mind the qualities demanded by competition and by the consumers' needs, the refiner works to produce the product required. Of the processes which have recently come to the fore, the most important are catalytic polymerization and alkylation, especially the latter. In this process an olefine is combined with a normal paraffin to form an *iso*paraffin in the motor- and aviation-fuel boiling ranges. Sulphuric acid is the most general catalyst, but others may soon be brought into commercial use. In combination with these two processes, catalytic dehydrogenation of paraffins to the corresponding olefines is carried out on a large scale, using oxides of Al, Ni, Cr, Fe, and V as catalysts.

Thermal dehydrogenation and alkylation are also processes in use commercially, a most important example being the thermal dehydrogenation of ethane to ethylene and its addition to *iso*butane to yield *neo*-hexane—a volatile high-octane-number constituent of 100 octane fuels. Less well developed are processes of isomerization for converting *n*-paraffins into the much more desirable *iso*paraffins, cyclization of chain hydrocarbons to the corresponding *cyclo*-compounds, and aromatization in which the final products are benzene, toluene, ethylbenzene, etc.

In the refining of light distillates, treated bauxite is used as a catalyst for removing mercaptans, sulphides, and disulphides, although thiophenes are not removed. Advantages of this method are a slight increase in octane number of the distillate itself, and a considerable improvement in the lead susceptibility.

In the processing of lubricating fractions, physical and chemical methods have been confined almost entirely to solvent extraction for removal of naphthenic, aromatic, and other undesirable fractions, and for removal of wax. The technique of filtration has also progressed with the introduction of new filter media and improvement of older products and methods.

Addition agents are coming into wider use either as oxidation inhibitors or as detergents for oil-oxidation products. Inhibitors include many N, S, halogen, and organic derivatives of both inorganic and organic elements and compounds. Detergents include, besides soaps and esters, substituted organic materials, both aliphatic and aromatic.

In the development of new products, many types of material are now synthesized commercially from petroleum. Solvents, alcohols, resins, plastics, synthetic rubbers, including butyl rubber and buna, are all derived from materials of petroleum origin, frequently beginning with olefines or *iso*paraffins as raw material. So great are the possibilities of developments of this nature, that there is no doubt that synthesis will become one of the most important branches of the petroleum industry. T. T. D.

395.* Stabilization Process of Natural Gasoline Extraction. R. W. Machen. *Petrol. Engr*, March 1940, 83–86.—The author describes in general terms a typical plant for the separation of natural gasoline into motor spirit and liquid gases. The system consists of a fractionating column of " bubble-cap " type having 26–40 plates in conjunction with conventional heat exchangers, reboiler or kettle, reflux coolers and condensers, temperature controls, back-pressure regulators, liquid-level controls, feed and reflux pumps. The raw gasoline enters the column where the vapour pressure of the tray liquid is equal to that of the hot charge, the stabilized gasoline is run off from the bottom of the column, and the liquid gases from the top. T. T. D.

396.* Water-Wash and Heat Reduce Salt Content 96%. Anon. *Refiner*, February 1941, **20** (2), 43–44.—Water-wash, heat, and settling are used to solve the problem of desalting crude oil in one plant. Despite treating on leases in Eastern New Mexico, crude oil from the Mescalero sand area comes to the plant with as much as 150 lb. of salt/1000 brl. in winter and 50 lb./1000 brl. in summer.

The process, adopted after limited success with previous methods, reduces the salt

content to 4·5 lb./1000 brl. in winter and as low as 2·5 lb./1000 brl. in summer. In addition to salt removal, the treating process allows sand and other solids to settle out, a process which is stimulated, since heat is a part of the process.

The treating plant consists of two horizontal settling tanks, three shell-and-tube heat exchangers, a steam coil, and a mixing nozzle. It functions ahead of the topping plant.

The operation of the plant is described. A. H. N.

397.* Further Improvements in Drum Construction. Anon. *Chem. Met. Eng.*, June 1940, **47** (6), 406–409.—Because of the convenience and attractive savings possible for the consumer through use of the new single-trip container over the returnable type, its adoption by the alcohol, solvent, paint, and petroleum industries was immediate, and an estimated annual production of 6,000,000 drums was attained by 1938. Certain faults were found, and the correction of these faults and the development of a newer and improved type drum are the subject of the paper. This type is the I.C.C. 5E. drum with 20-gauge sidewall.

A test programme in studying the new type drum included the following: (1) physical and chemical characteristics of the steels used, and fabricating techniques; (2) effect of yield-point of steel on the stability of swedged-out rolling hoops; (3) effect of yield-point on resistance to denting and weaving; (4) service tests to compare the 20-gauge I.C.C. 5E. drum of stiff steel with the all 18-gauge I.C.C. 5E. drum fabricated from ordinary soft steels. The test programme was inaugurated during October 1938, and extended over a period of a year. The tests are described, and the results are illustrated by photographs. Results are favourable.

In developing the drum as a single-trip container it was intended to be used primarily for hazardous liquids of low specific gravity, such as alcohol and various solvents. This drum should not be overloaded, and the committee has recommended that the maximum nett weight of contents shipped therein should not exceed 450 lb. Better-quality sheet steel is now available, and improvements in design and fabrication have been made. It is expected that the I.C.C. 5E. drum with 20-gauge sidewall will be even more extensively used in the future. A. H. N.

398.* A New Heat-Transfer Medium. W. E. Kirst, W. M. Nagle, and J. B. Castner. *Chem. Met. Eng.*, July 1940, **47** (7), 472–475.—A molten mixture of nitrates and nitrites of sodium and potassium, known as HTS, has recently come into large plant-scale use as a heating and cooling liquid. This mixture, which consists of approximately 40% $NaNO_2$, 7% $NaNO_3$, and 53% KNO_3, by weight, has been adopted because it has a low melting point, a high heat transfer rate and a thermal stability, and a lack of corrosive action on steel at temperatures above those obtainable with Dowtherm, hot oil, or steam.

While similar nitrite and nitrate mixtures have been employed for a great many years in molten baths for the heat treatment of metals and in small installations requiring heat removal at a high temperature level, their use as heat-transfer salts on a large scale began with the installation of the Houdry units for the catalytic cracking and refining of petroleum.

Heat-transfer characteristics of steam, mercury, molten lead, and a patent salt mixture called " NS " are discussed. Hot oil, Dowtherm, and HTS are the principal commercial heat-transfer fluids now available for installations in which the temperature of steam is insufficient and in which flue gas is inapplicable, for any reason. The practical top limit for oil is somewhat over 550° F., and that for Dowtherm is approximately 700° F., above which temperatures these organic materials begin to coke and plug up pipe-lines. The upper practical limit for HTS has not been established definitely. At present it appears to lie in the range between 900° and 1100° F. depending on operating conditions and economic factors. The salt mixture can be used as a heating or cooling fluid at atmospheric pressure and at temperatures that are 200–400° F. higher than the top limit for Dowtherm.

Properties of HTS are detailed, with graphs giving the variation of such properties as density, viscosity, and heat-transfer coefficients under different conditions. Further, the stability, corrosion effects, safety precautions, and explosibility are all discussed. A. H. N.

399.* **New Trends in Boiler Feed-Water Treatment.** F. G. Straub. *Chem. Met. Eng.*, July 1940, **47** (7), 477–479.—The most common classification of boiler feed-water problems is (1) scale, (2) corrosion, (3) embrittlement, and (4) carry-over. The first two difficulties may be experienced at all points in the water-stream cycle of the power plant, whereas the last two occur only in the steam boiler. There are many methods of boiler-water treatment which prove suitable for one or all of these problems. However, the methods of attack may be roughly classified as treatments used internal or external to the boiler. In the more recent years it has proved advisable to use a combination of both the external and internal treatments. These treatments are discussed.

The corrosion most commonly experienced in the power-plant has resulted from dissolved oxygen. The modern plants have resorted to every method available for the removal of the oxygen from the water prior to entering the boiler feed-lines. This has resulted in almost universal chemical treatment being resorted to for the elimination of the last trace of oxygen left after deaeration. Chemicals such as iron, ferrous hydroxide, sodium sulphite, and various organic materials are being extensively used.

Embrittlement in steam boilers results in the failure of the steel in the riveted areas and the areas in the vicinity of the rolled tube-ends. This failure has been attributed to the action of the sodium hydroxide in the boiler-water concentrating in the capillary spaces present in these areas and attacking the highly stressed boiler metal, with the resultant cracking of the steel. Methods of chemical treatment have been worked out whereby the embrittling action of the water may be stopped. This has involved the maintenance of definite amounts of sulphates and chlorides or organic material in the lower-pressure boilers and the reducing of the silica content in the higher-pressure boilers.

Washing steam with feed-water, to reduce the total solids carried over by the steam, and thus to reduce difficulties in the form of turbine-blade deposits, forms the concluding part of the review. A. H. N.

400.* **Petroleum Toluol.** Anon. *Chem. Met. Eng.*, August 1940, **47** (8), 535–537.—The oldest method of obtaining toluol from petroleum consists of fractionation—generally followed by chemical or physical extraction—of certain crudes. A cut of relatively narrow boiling range containing the toluol (b.pt., 231° F.) is taken from the crude. Subsequently a high degree of fractionation or extraction with some such solvent as liquid SO_2, or a combination of fractionation and extraction, yields toluol of the required purity. This process is of limited application. The production of crudes containing appreciable quantities of toluol is quite limited. No comprehensive study of American crudes with respect to toluol content is available.

It is noted that even if a "toluene fraction" of a naphtha were entirely toluene, and if a naphtha containing 6% of this fraction constituted 30% of the crude, the toluene content of the crude would be only 1·8%.

To obtain more toluol for T.N.T. purposes other means are necessary. One promising method is that for which the groundwork was laid during world War I—low-pressure, high-temperature cracking of petroleum oils. There is some evidence that the characteristics of the oils do not play as vital a part in the yields of toluene as do the conditions under which cracking is carried out. Details of cracking processes are given.

A third means of producing toluol exists in the thermal pyrolysis of hydrocarbon gases from petroleum, such as natural gas and the cracked gases made in refineries as by-products. As in the cracking of liquid feed-stocks, the reactions of the process are complex, and result in considerable amounts of olefines and aromatics.

The production of toluol by the catalytic aromatization of *n*-heptane is another process which is receiving consideration. Normal heptane occurs in many crudes, and may be separated therefrom by fractionation. Toluol is then made by cyclization with dehydrogenation. Synthetic methods using chromic oxide catalysts are briefly mentioned. Another process that is believed to yield large quantities of aromatics although there has been no published account of it, is the so-called hydro-forming process. The principal function of the process, however, is to produce high-octane motor and aviation fuels. A. H. N.

401.* **Economy in Tube Grouping in Round-Shell Exchangers.** Z. G. Deutsch. *Chem. Met. Eng.*, August 1940, **47** (8), 538–540.—The general requirement of the tube-sheet

itself, outside the elementary one of strength to resist bursting pressure or vacuum collapse, is to support the tubes with a tight, maintenance-free joint. When the fluids separated by the tube surfaces of a heat exchanger have nearly the same density and specific heat, the cross-sectional areas should be as nearly alike as possible. This is not invariably true, but frequently so in the author's practical experience. For such problems the best approach to "theoretical" economy of materials is obtained by using the smallest tube diameter, the longest tubes, the closest possible tube spacing, the thinnest possible tube walls that can be justified.

The paper discusses further the arrangements of tubes in the shell, and two typical arrangements are shown to be preferable to the other two studied. Tables and charts are given so that designers can utilize them in arriving at an economical number of tubes and a preferable arrangement of such a number of tubes to any other.

The data in this paper have been computed only up to about 120 tubes. With larger numbers of tubes there is relatively less difference in area ratio. Also, in working with larger tube bundles the designer is generally faced with circumstances which make the use of a perfectly symmetrical bundle less and less likely. This is because it is necessary to accommodate certain nozzles, connections, circulating pipes, etc., which interfere with the uniform placement of tubes across the entire cross-sectional area of the shell. A. H. N.

402.* Gulf Introduces New Petroleum Refining Process. Anon. *Chem. Met. Eng.*, September 1940, **47** (9), 626.—The polyform process differs from thermal cracking in that the oil is processed in admixture with normally gaseous hydrocarbons, particularly propane and butane, at higher temperatures and pressures. The result is a higher degree of conversion/pass, with a consequent increase in yield and octane number.

The theory of the process is that, in addition to the normal cracking of long hydrocarbon molecules which is obtained at these high temperatures and pressures (about 1000° F. and 1000 lb./sq. in.), a certain amount of polymerization of the C_3 and C_4 hydrocarbons will occur. Also the introduction of the gases cuts down coke formation, allowing the unit to operate at higher temperatures, with the consequent increase in conversion/pass.

The principle of the process is that the charge to the furnace must be one continuous phase. Normally, the liquid phase tends to be suspended in the vapour phase (largely the gaseous additives) in the form of minute droplets. These are thrown out against the tube wall, forming a thin oil film. Heat transmitted through the tube wall must pass through this oil film, which therefore determines the coking characteristics of the tube. In order to produce a continuous vapour phase, the proportion of light hydrocarbons must be increased to a point where the critical temperature of the mixture is reduced to the temperature of operation. This does away with the oil film, substituting a vapour film, which is less susceptible to coking.

Details of a typical plant are given. A. H. N.

403.* Notes on the Design and Operation of a High-Temperature Dowtherm System. R. E. Hulme. *Chem. Met. Eng.*, October 1940, **47** (10), 685–687.—Dowtherm is the eutectic mixture of diphenyl and diphenyl oxide. Many high-temperature heating processes are now being carried out through the use of indirect heat-transfer media such as Dowtherm. Compared to direct heating, any vapour medium makes possible much closer control, usually with marked improvement in yield and quality of the product. In comparison with steam, however, Dowtherm vapour permits temperatures up to about 700° F. at relatively low jacket pressures, and still without appreciable deterioration of the medium. However, many new problems in design, materials, and technique are thus introduced. Several of these problems of manipulating, maintaining, and controlling Dowtherm systems are discussed. A. H. N.

404.* Safety and Fire Prevention. Anon. *Chem. Met. Eng.*, October 1940, **47** (10), 700–706.—The paper deals with American safety organizations and recommendations. After studying the frequency and severity of various types of accidents and analysing their causes, the following conclusions summarize the findings of the writers.

Chemical industry in 1939 set some enviable records in accident prevention, ranking seventh in frequency and seventeenth in severity among the thirty major injuries

charted by the National Safety Council. But there is urgent need for improvement, particularly in the records of fatalities.

Contrary to popular opinion, most accidents in chemical industries are not caused by fumes and flames, but by slips and falls, common tools and machinery—the same as in all other industries. The reason is that the chemical group has learned how to protect itself against chemical hazards, but has failed to conquer some of the common causes of injury.

Accidents annually cost chemical industry approximately $10,000,000, or $40 per worker/year. There are handsome dividends in safety work for those who apply it in the right way.

Fire-prevention practices and equipment have changed to keep pace with the rapid development of new chemical products and processes. Obsolete, antiquated fire-extinguishers and fire-fighting apparatus had best be discarded before it is too late.

Recent chemical engineering graduates have been criticized because of lack of knowledge about industrial hazards and failure to appreciate the vital relation between safety and plant efficiency. Several educational institutions are awakening to the need for training in at least the fundamentals of safety engineering. Others should follow. A. H. N.

405.* Applying Water-Pumping Equipment to Process Pumping Problems. G. L. Montgomery. *Chem. Met. Eng.*, December 1940, **47** (12), 840–843.—A process industry where vertical pumps are finding considerable application for process liquid handling is the petroleum industry. For quick unloading of crude oil or fuel oil from tankers to barges or shore, deep-well turbine pumps are being installed directly on the boats, with the motors above decks and the pumps submerged in the oil compartments of the tanker's hold. This has proved to be an economical and safe unloading method.

In refinery operation, and also in handling such refinery products as gasoline and butane, the vertical pump is finding wide application. For use where the service is hazardous, some pump designers have brought out special pumps in which the motor is submerged in an isolating liquid, so that fire or explosion hazard is minimized.

In pumps of this type the motor, below the pump, and the pump itself are inserted in a heavy cylindrical barrel and suspended from the flanged barrel cover. The motor runs in oil, and a mercury seal prevents the pumped liquid from entering the motor. The lower part of the barrel, surrounding the submersible motor, is filled with an isolating liquid that is immiscible with the liquid being pumped. This prevents the possibility of the motor igniting any flammable liquid that the pump handles. The liquid enters a suction nozzle at the top of the barrel and floats on the isolating liquid. Pump discharge is through the top of the barrel. Examples of vertical centrifugal pumps in refinery works are given.

One distinct advance made in recent years is the development by almost all pump-makers of types of small, standard centrifugal pumps in which the motor and pump are built together as a unit, often with the motor mounted directly on the pump-casing or vice versa. With such pumping units the assembly can be mounted in any convenient position, with the shaft horizontal, vertical, or at an angle. This is a great help in making installations in crowded locations or directly on the equipment served by the pump.

Where positive delivery in exact quantities is in demand for process work, the rotary pump continues to give excellent service. An example is given of seven rotary pumps in a lubricating-oil blending plant. A. H. N.

406.* South African Materials as Substitutes for Imported Earths in Connection with Oil Refining. G. A. Smith. *J. Chem. Met. and Min. Soc. S. Africa*, 1940, **41**, 197–208.—An investigation into the possibility of finding South-African-produced substitutes for lubricating-oil refining earth is detailed. Normally such material would be fuller's earth, bentonites, bauxite, silica gel, or carbon. Bauxite and bentonites are not available in South Africa, and silica gel is not considered to be very efficient for lubricating-oil refinement. The investigation was therefore mainly concerned with the little fuller's earth which was available, with carbon and with two unusual possibilities —namely, vermiculite, a form of mica, and magnesite or naturally occurring magnesium carbonate.

The improvement in colour when a used lubricating oil is agitated for a standard time at 150° C. was utilized to assess the efficiency of each of the materials used.

An active form of magnesium oxide was prepared by calcining magnesite at 700° C. Although slightly inferior to recognized treating earths in decolorizing ability, the active magnesia produced at least as stable a regenerated oil, judged by British Air Ministry oxidation tests, etc., as a highly active bentonite. The filtration rate of the magnesia-treated oil is slow, but can be improved by the addition of diatomaceous earth. The latter increases the porosity of the magnesia slime pad formed during filtration.

The temperature of calcining the magnesite is critical, and heating above 700° C. reduces the activity of the product. Particle size must be less than 200 B.S.S. mesh. The production cost of the magnesia in South Africa is calculated to be ¼*d.* per lb. Imported earth costs 5½*d.* per lb.

Attention is directed to a method of preparing active magnesia by the lime precipitation and subsequent calcination of magnesium hydroxide from sea-water.

Fine-mesh active carbon produced from South African coal was found to have extremely good oil-refining properties.

Exfoliated vermiculite, which, because of its very large surface area, was expected to be very efficient, was, in fact, very disappointing. Its failure is attributed to lack of the " capillary pores " which in an active material absorb the colouring matter in oil.

The attempt to find a suitable South African clay was not successful. A partly active clay was produced in the Riversdale district, and the activity of this was improved by acid-washing to remove carbonates, but the results were not impressive, and it was concluded that South Africa does not possess any natural treating clays.

During the work it was demonstrated that there is no correlation between the malachite-green absorptive power of a clay and its decolorizing ability. T. C. G. T.

407.* Slurry-Type Copper Chloride Treater. F. A. Deering, *Oil Gas J.*, 5.9.40, **39** (17), 43.—Hypochlorite treatment of stabilized light straight-run mixed with cracked gasoline has been replaced at an Arkansas City refinery by treatment with a slurry of 200-mesh fuller's earth and copper chloride. The gasoline is caustic washed, dehydrated in a salt tower, steam heated and passed to the base of the slurry tower. Before the tower, an eductor leads oxygen (averaging ¼ cu. ft. per brl., but depending on the mercaptan content) into the stream. The stream leaving the slurry tower is water-washed, and scrubbed with water and passed into a further salt tower. The final product is doctor sweet, clear, and bright. A blend of 20% copper-treated stock and 80% cracked gasoline requires 12% less tetra-ethyl lead than when using hypochlorite, whilst the induction period is approximately 30 min. longer. C. L. G.

408. Patents on Refining and Refinery Plant. W. W. Groves. E.P. 531,120, 30.12.40. Appl. 12.7.39. Improvement in the process of dewaxing hydrocarbon oils, such as mineral oils, tars, etc., in which the oil is diluted with a mixture of liquid sulphur dioxide and an auxiliary solvent which increases the solvent power of the sulphur dioxide. According to the invention, the oil to be dewaxed is passed after dilution into chillers having scraping devices and constructed as double pipe-chillers in counter-current to cold liquid sulphur dioxide.

C. H. Leach. E.P. 532,604, 28.1.41. Appl. 11.9.39. Design of a heat-exchange apparatus intended particularly for use in refining petroleum oil. The apparatus comprises a fixed head, a plurality of floating heads spaced from the fixed head, heat-exchange tubes connected between the fixed and floating heads to form a fluid passage, a shell enclosing the tubes and floating heads, and a baffle inside the shell for forming a vapour passage.

Standard Oil Development Company. E.P. 532,792, 30.1.41. Appl. 20.8.39. Method of separation of a hydrocarbon fraction of the class of naphtha, kerosine, and light gas-oil into its relatively more paraffinic and relatively more aromatic constituents. The hydrocarbon fraction is separated with tetraethylene glycol.

R. E. Burk and E. C. Hughes. U.S.P. 2,225,546, 17.12.40. Appl. 31.12.37. Process for dewaxing oils by subjecting them to the action of butylamine, chilling, and separating the wax.

B. Hopper. U.S.P. 2,227,089, 31.12.40. Appl. 7.2.38. Stabilization of oil treated with a copper reagent in the presence of oxygen. The copper-sweetened oil is treated with a carbonate of a metal above hydrogen in the electro-chemical series.

D. W. Mapes and E. M. Dons. U.S.P. 2,227,377, 31.12.40. Appl. 23.9.38. Prevention of oxidation in using propane and acid to refine lubricating oils. A lubricating-oil stock is dissolved in liquid propane, treated with sulphuric acid, and the sludge removed. Thereafter finely divided neutralizing earth is mixed with the solution of acid-oil and propane, and finally the propane is distilled from the oil.

W. F. Houghton. U.S.P. 2,229,209, 21.1.41. Appl. 19.8.38. Method of separating hydrocarbon oil containing paraffinic and naphthenic constituents into a plurality of fractions of progressively increasing paraffinicity. H. B. M.

Synthetic Products.

409.* Rubber from Petroleum Gases. D. North. *Chem. Met. Eng.*, April 1940, **47** (4), 220–224.—All commercial synthetic rubbers are produced, in part at least, from one or from either one of two of the following unsaturated hydrocarbon gases: butadiene, *iso*butylene, acetylene, or ethylene, which are derived from petroleum, coal, or, as with butadiene in Russia, from vegetable sources. Buna rubber is derived from butadiene, obtained in Germany from acetylene ex carbide, or more recently from hydrocarbon gases of synthetic petroleum production, and in the United States from petroleum gases. *iso*Butylene is obtained from petroleum gases. Neoprene is derived from acetylene, Thiokol from ethylene, and vinyl chloride from either acetylene or ethylene.

Immense strides also have been made in "rubbers" derived primarily from materials other than petroleum gases, notably neoprene, Thiokol (one raw material comes from cracked hydrocarbons), and the polymerized vinyl chlorides in the United States and "Sovprene" in Russia. Neoprene is derived by catalytic synthesis of acetylene to monovinylacetylene, and reaction of hydrogen chloride on the latter to form chloroprene. Chloroprene is then polymerized to the rubber-like material neoprene. Excellent resistance to animal, vegetable, and mineral oils, to sunlight, heat, ozone, and most chemicals has led to widespread use of neoprene in gasoline and oil hose, protective clothing, footwear, packing, and gasket material, protective coverings for wires and cables, and many other uses.

Similarly, other synthetic rubbers are described and their manufacture is outlined briefly. Butadiene rubbers are treated in greater detail than the others. The process of purifying butadiene consists of the formation of the temporary derivative butadiene-sulphone from which a resultant butadiene product of over 99·5% purity is obtained. Its superiority over German butadiene is indicated in that an atmosphere of nitrogen is unnecessary for polymerization to synthetic rubber, as with the German product.

The best grades of butadiene rubbers are resistant to animal, vegetable, and mineral oils, but swell in aromatic hydrocarbons, ketones, alcohols, and esters, and in chlorinated hydrocarbons and organic bases they swell more than natural rubber. In ageing, exposure to sunlight, in resistance to heat, ozone, moisture, abrasion, and flexing, in permanent set and creep, and in hysteresis loss, they are superior to natural rubber. The potential supplies of butadiene are enormous.

Rubbers produced from *iso*butylenes are discussed from the viewpoints of properties and utility. The four principal outlets for these rubbers from *iso*butylene are in compounding of lubricating oils, in various modifications of paraffin wax such as Parofilm, in rubber compounding, and in the manufacture of adhesives such as tin pastes, paper-backed metal foil, facing of bottle cap-liners, and heat-sealing compounds. A. H. N.

410.* Synthetic Glycerine from Petroleum. E. C. Williams. *Chem. Met. Eng.*, December 1940, **47** (12), 834–838.—Synthetic glycerine may be obtained from carbon monoxide and hydrogen. This process involves the condensation of carbon monoxide with formaldehyde to give glycolic acid, reaction of this with a formal, and ultimately the alcoholysis of a formaldehyde derivative of glycerine.

Of the numerous syntheses possible, however, the most direct are those starting with the three-carbon skeleton. This is particularly so when petroleum is to be made the ultimate starting material, since unlimited amounts of propylene and propane are available from this source. Even when these limitations are made, the possible syntheses are legion. Thousands of investigations were necessary to determine which one might have the best commercial possibilities. A line of synthesis starting with propylene and proceeding to allyl chloride to allyl alcohol (or to glycerine dichlorohydrin) to glycerin was finally chosen. The step-by-step development of this process is described in the order of the compounds mentioned. It is emphasized that the discovery of the "hot chlorination" of propylene made the process feasible, also a larger-scale plant might not use the allyl alcohol step.

The glycerine hydrolysate is concentrated in much the same way as soap glycerine lyes, and then vacuum distilled. This leads to a crude glycerine which does not yet meet commercial specifications. However, by making appropriate cuts during the distillation, extracting with a solvent such as xylene (U.S. Pat. 2,154,930), and redistilling, a glycerine is secured which meets all commercial specifications.

A. H. N.

411.* *neo*Hexane for 100-Octane plus. M. E. Clark. *Chem. Met. Eng.*, April 1940, **47** (4), 225–227.—The prefix *neo* indicates the presence of a carbon atom attached by all four valence bonds to other carbon atoms. Thus *neo*-hexane is 2:2-dimethylbutane. Its octane rating is 92; its blending properties, however, make it possible to manufacture fuels of 115 octane numbers. This is due to the high lead susceptibility and high volatility of the hydrocarbon. The following are the properties of *neo*-hexane: Reid vapour pressure, 9·5 lb.; A.P.I. gravity, 84·9°; A.S.T.M. octane number, 94; boiling point, 121·5° F.; specific gravity, (0·6494) 20/4° C.; refractive index n_D at 20° C., 1·36887; and its freezing point is −144·8° F.

It is produced by thermal alkylation, using ethylene derived from a mixture of paraffin gases by cracking them at 1425° F. and a few lbs./sq. in. above atmospheric, and joining the ethylene with *iso*butane at high temperatures and pressures using excess of *iso*butane. There are a number of products of this reaction which are fractionated. Propane, ethane, and other light materials are eliminated, *iso*butane is recirculated, and *neo*-hexane and other heavy materials are withdrawn and refractionated to yield practically pure *neo*-hexane. A. H. N.

412. Patents on Synthetic Products. U.S. Industrial Alcohol Co. E.P. 531,256, 1.1.41. Appl. 23.6.39. Production of ethylene oxide by passing a gaseous mixture containing ethylene, oxygen, and a non-reactive diluent through a catalyst adapted to promote oxidation of the ethylene at a temperature between 100° and 450° C. at a linear velocity of between 20 and 500 cu. ft. per hour per sq. in. of cross sectional catalyst area.

M. M. Holm, A. L. Lyman, and M. F. Miller. U.S.P. 2,224,349, 10.12.40. Appl. 31.12.34. Production of synthetic hydrocarbon oils of high viscosity index and of higher than 40 sec. Saybolt Universal viscosity at 210° F., and having the properties of viscous liquids rather than of plastic solids.

W. B. Plummer. U.S.P. 2,227,691, 7.1.41. Appl. 29.6.39. Preparation of a synthetic lubricating oil possessing substantially no extreme pressure properties. The composition consists substantially of a synthetic lubricating oil obtained by the condensation of an olefin and about 0·005–0·05% of stably bound sulphur.

H. B. M.

Fire Prevention.

413.* Fire Extinguishers and Fire Hazards in the Chemical Industry. N. C. Jones. *Chem. & Ind.*, 1941, **60**, 113–119.—Practically all known fire-extinguishing media are reviewed. Fire extinguishers as used in the U.S.A. are approved for use only on

the type of fire to which the Underwriters Laboratory consider they are adaptable, and in no instance has a fire extinguisher been approved for use on every class of fire. In Great Britain fire extinguishers may be approved by the Fire Officer's Committee, after examination and test by the Board of Trade and other competent authorities.

For handling petroleum fires foam and mechanical foam are excellent. Carbon dioxide, carbon tetrachloride, and methyl bromide are also effective in certain circumstances. Dry chemical compound powder propelled by carbon dioxide is also most effective, and very quick-acting in extinguishing petroleum fires. This latter extinguisher, which is largely employed in the U.S.A., normally uses an inert gas, nitrogen, or carbon dioxide, to propel the dust, which is mainly sodium carbonate. The hand models weigh 26–55 lb., and contain 8–25 lb. of chemical dust. The carbon dioxide is contained in a cartridge, and the pressure is sufficient to blow the compound a distance of over 25 ft. The model holding 25 lb. of compound will handle fires of 150 sq. ft. Portable models having a capacity of 150 or 350 lb. of compound are equipped with nitrogen cylinders which supply sufficient pressure to throw all the compound 50 ft. The advantages of the apparatus are :

1. Simple and dependable.
2. Clean in action and controllable.
3. Unaffected by cold.
4. No damage to materials, plant, or machinery.
5. Effective over wide range.
6. Reasonably cheap.
7. Effective on gas, oil, inflammable liquids, and electrical fires.
8. Can be used in the open or in confined places.
9. Dry powder acts as an absorbent.

The efficiency of this type of extinguisher was illustrated during experiments with oil-incendiary bombs. The residual oil from a paraffin fire which had been extinguished by such means, when re-ignited was not extinguished by foam.

Water, acid and soda, foam, mechanical foam, chemical liquid extinguishers such as carbon tetrachloride and methyl bromide, inert gases, loaded stream (*i.e.*, solution of alkali metal salts), and systems that combine several of these methods, are all outlined and their individual advantages tabulated. The uses and application of heat fuses for automatic systems are outlined, as also are numerous hazards peculiar to special industries. T. C. G. T.

Chemistry and Physics of Petroleum.

414.* Elements of Vaporization and Condensation. Part XI. R. L. Huntington. *Refiner*, February 1941, **20** (2), 47–50.—The paper furnishes illustrative exercises and problems for the subjects treated by the author in the previous ten parts. Differential and flash vaporization as well as fractionator operations are studied. A. H. N.

415.* Hydrogen Content as a Basis for Correlating the Specific Heat of Liquid Hydrocarbons and Petroleum Fractions. J. Griswold and H. A. Alves. *Refiner*, February 1941, **20** (2), 52–54.—From the assumption that the molecular-heat capacity of a liquid hydrocarbon is the sum of the atomic-heat capacities of its carbon and hydrogen atoms, a linear relation between specific heat at 32° F. and the weight-% hydrogen results applicable to petroleum. The correlation is good between normal paraffin and aromatic hydrocarbons, but not for naphthenes and olefines by this procedure.

Specific-heat data on petroleum fractions for which the hydrogen content could be estimated are obtained from the literature. These and experimental values correlate very nearly as closely as by the best equations hitherto developed, by the equation :

$$(C_p)\ 32°\ \text{F.} = 0{\cdot}0152\ (\text{Wt.-\%H}) + 0{\cdot}2448.$$

The data for pure hydrocarbons and for petroleum fractions are given in graphical form. Estimation of hydrogen content is made by means of Watson's correlation of the characterization factor and hydrogen content. Another formula used was:

$$\text{Wt.-\%H} = 14{\cdot}3 + 0{\cdot}175\ (^\circ \text{A.P.I.}) - 7500^\circ Tm.$$

where Tm is the mean average boiling point. Experimental work is also described.

A. H. N.

416.* Packed Columns for Close Fractionation. L. B. Bragg. *Refiner*, February 1941, **20** (2), 55–64. *Paper presented before American Institute of Chemical Engineers.*—The packings studied in particular are the Stedman types. The single-cell, conical-type Stedman packing is at present made in three sizes: 0·375-in., 0·750-in., and 25-mm. (0·984-in.) nominal diameters. The multiple-cell, triangular pyramid-type Stedman packing also is made in three round sizes: 2·080-in., 3·080-in., and 6·080-in. diameters. A fourth packing of this type is made having an equilateral triangular cross-section 6 in. on a side, these sections being fitted together to pack columns of hexagonal cross-section. These packings are usually constructed of 40 × 60-mesh wire cloth, using 0·009-in. diameter wire.

The operations of the single-cell and multiple-cell packings are detailed. In the first type reflux liquid flows along the wire cloth and seals the openings of the mesh. The liquid flows out towards the walls of the column on a cone that is concave downwards, and then back towards the centre of the column on a cone that is concave upwards, which is welded to the first cone at the outer edge. The lower cone is welded to another still lower cone at the centre, and the liquid flows through the mesh at the point of junction, then outward towards the walls on this lower cone, and so on until the liquid drops off the lowest cone of the column. The vapour enters the space between two cones, which are welded around the outer edges, through the vapour hole in the lowest cone. The vapour then flows through the space between these two cones, practically at right angles to the axis of the column, and out through the vapour opening in the upper cone of the pair. The vapour then divides and flows around the point where two cones are joined back to back, and across to the side of the column where it first entered the packing. This flow is repeated until the vapour leaves the packing at the top of the column. The working of the multiple cell is similarly detailed.

The packings were tested with mixtures of benzene and ethylene dichloride at total reflux and atmospheric pressure. The data obtained were worked up in the form of column operation factors which permit accurate comparisons between various types of packing and different diameters of columns. Data on other types of columns are included. These data have been converted to be comparable with data on ethylene dichloride mixtures and worked up in the same manner. A. H. N.

417.* Charts Solve Orifice Equations. H. S. Winnicki and R. Koch. *Chem. Met. Eng.*, January 1940, **47** (1), 24.—An alignment chart for the solution of orifice equation for both gas and liquid flow is presented. The ranges of operation are as follows: rate of flow: for liquids from 1–10,000 gals./hr., for gases from 0·001–10,000 cu. ft./min.; orifice diameter: for liquids 0·1–1 in., for gas 0·07–2·0 in.; gas temperatures, 400–1000° F. abs., pressure 0·1–250 lb./sq. in. abs. A. H. N.

418.* Vaporization Equilibria. M. Gilbert. *Chem. Met. Eng.*, April 1940, **47** (4), 234.—A chart is presented which may be used in vaporization equilibria calculations on multi-component systems in order to reduce the time necessary to arrive at a solution by trial-and-error methods. The method requires a maximum of three attempts before obtaining an answer. The theory on which the chart is based is derived in the paper for complex mixtures from following Henry's and Raoult's laws, where the vapour pressures lie between those of the pure components.

An illustrative example is solved in detail to make clear the use of the chart.

A. H. N.

419.* Estimation of Unsaturated Hydrocarbons by Bromine Addition. J. S. Green. *J. Inst. Petrol.*, 1941, **27** (208), 68–71.—The bromine number can be used for compara-

tive purposes as a measure of unsaturation in complex hydrocarbon mixtures provided that the conditions of the reaction are precisely specified. An inhibition effect which might be a potential source of error was observed in brominating heptane, nonene, and a benzole fraction by the Francis method, but this did not occur when using the Lewis and Bradstreet titration technique. For the estimation of the actual percentage of unsaturateds, the bromine-absorption method is unreliable unless the molecular weight and type of the olefines present can be determined or estimated with accuracy.

B. M. H. T.

420.* **Catalytic Vapour-Phase Oxidation of Aliphatic Kerosine Fraction.** W. G. Parks and E. F. Story. *Oil Gas J.*, 5.9.40, **39** (17), 54.—A brief review of the oxidation of kerosine with heterogeneous catalysts is given, followed by detailed results on experimental work on the vapour-phase oxidation of an aliphatic hydrocarbon, C_{12} to C_{14}, fraction from kerosine using homogeneous catalysts—nitric acid vapour and tetraethyl lead. The latter catalyst was preferred owing to the explosive nature of reaction products from the former. With nitric acid vapour the highest yields of aldehydes (20% on the oxidized hydrocarbons) was obtained at 300° C. lengthening reaction time giving higher yields. Acid production (up to 6%) was favoured by lowering temperature and reaction time and increasing the air hydrocarbon ratio. Tetraethyl lead was a more effective catalyst, the optimum results under different conditions being 20% aldehydes and 16% acids.

It is considered that commercial production of these mixed aldehydes and acids with their derivatives is economically possible. Re-circulation of remaining hydrocarbons tended to form acids rather than aldehydes, tetraethyl lead giving traces of alcohols (though none were produced with nitric acid vapour) suggesting that oxidation is by hydroxylation rather than by peroxide formation. Further work is in progress.

C. L. G.

Analysis and Testing.

421. **A.S.T.M. Standards 1940 Supplement. Parts II and III.** American Society for Testing Materials.—The Supplement to A.S.T.M. Standards, issued for the first time in 1940, contains the new and revised standards and tentative standards adopted since publication of the Book of A.S.T.M. Standards in 1939 and replaces the Book of Tentative Standards.

The Supplement is issued in three parts of which Parts II and III are of principal interest to the petroleum industry.

Part II includes specifications for Asphalt Plank, Cut-Back Asphalt and Quick-Setting Emulsified Asphalt and methods of testing of emulsified asphalts and for water in petroleum products and other bituminous materials.

Part III includes specifications for Gasoline and Stoddard Solvent, and the following new or revised methods of testing: Ramsbottom Carbon Residue, Carbonizable Substances in White Mineral Oil, Distillation of Gasoline, Naphtha, etc., Natural Gasoline and Plant Spray Oils, Dropping Point of Grease, Analysis of Grease, Pensky Martens Closed Flash Point, Gum Stability of Gasoline, Electrical Insulating Oils, Knock Characteristics of Motor Fuel, Precipitation Number of Lubricating Oils, Unsulphonated Residue of Plant Spray Oils, Reid Vapour Pressure, Water Content, Water and Sediment and Calculation of Viscosity Index.

Many of the revisions are of a minor or editorial character, but it should be noted that in the method of test for Ramsbottom Carbon Residue a metal coking bulb has been prescribed in place of the glass bulb and in the Pensky Martens Closed Flash the rate of heating for Cut-Back Asphalts and other viscous materials has been reduced from 4–6° F. per minute to 2–3° F. per minute. A new method for determination of water in grease uses the cone-shaped centrifuge tube as receiver, and this is centrifuged to assist separation of the water and xylol at the end of the distillation, water-free oleic acid is added to the distillation flask as an anti-foaming agent.

The method for determination of dropping point of grease uses the Ubbelohde type of apparatus.

A. O.

422.* Polarographic Determination of Lead in Gasoline. H. A. Frediani and L. A. Bass. *Oil Gas J.*, 26.9.40, **39** (20), 51.—The methods which have been suggested for determining lead in gasolines are listed, and it is stated that the most widely used method is that of Calingaert and Gambrill which involves refluxing the gasoline with HCl and estimating the lead in aqueous solution by a gravimetric or volumetric method.

The authors extract the lead by refluxing with HCl, but determine it in the aqueous solution by a polarographic method. This is considered to save time without sacrificing precision. The dropping mercury electrode is used in this analysis, and it involves current-voltage curves obtained in solutions utilizing a highly polarized cathode and a non-polarizable anode.

Curves are drawn for solutions containing known amounts of lead for comparison with the experimental results. D. L. S.

423.* Identification of Bitumen in Paving Mixtures. A. W. Attwood and D. C. Broome. *Petroleum*, October 1940, **2** (6), 183.—The development of colorimetric methods of identifying bitumens is discussed, and a description given of an apparatus and method of test which has been developed for this purpose. Visual determinations of the colour of bitumen solutions present difficulties owing to varying sensitivity of eyes to the various parts of the spectrum, lack of repeatability, possibility of matching colours by varying combinations of others, and to the fact that standard colour glasses do not transmit light of only that colour. Photo-electric methods are to be preferred, types of instruments available being: (1) the Hirsch Muller, using various vapour-discharge lamps, which is expensive and slow in operation; (2) apparatus consisting of incandescent electric lamps and standard colour filters, and (3) comparometers in which the light from a single lamp passes through two liquid cells connected in opposition. The present investigation resulted in the choice of type 2, the Panchrometer being evolved for the purpose. It consists of a high-intensity light source controlled by a rotary slotted diaphragm, a set of filters covering the spectrum from infra-red to ultra-violet, and a vacuum-type photo-electric bridge connected to a single-stage thermionic valve amplifier. The test is carried out by dissolving the bitumen in benzene to a concentration of 2·5 gm./litre, decanting and centrifuging, placing a 2-mm.-thick cell of the solution in the apparatus and measuring the light transmitted using different colour filters, by the P.D. from the photo-electric cell, the apparatus being first checked against pure benzene. This gives a colour grading of the bitumen throughout the spectrum, which is sufficiently characteristic for the nature of the crude and the approximate penetration to be determined if the corresponding basic figures are known. In addition, the Panchrometer may be used to detect overheating, changes due to ageing and sedimentation from asphaltic cements, and the reaction (adsorption) between bitumen and aggregate.

Colour analyses of a wide range of bitumens are included and a critical survey is made of the available pieces of equipment forming the apparatus. C. L. G.

424.* Testing the Permeability of Asphaltic Surfaces. Anon. *Engineering*, 1941, **151** (3923), 235.—A description is given of a simple type of permeometer consisting essentially of an open cylinder with a base flange faced with a rubber ring. The instrument is held down on the surface to be tested and filled with a measured amount of water, the amount leaking through the surface in a known time giving a measure of the permeability of that surface. B. M. H. T.

425.* Laboratory Oxidation Tests for Lubricants. F. Jostes and A. Hann. *Refiner*, February 1941, **20** (2) 65–69.—The apparent impossibility of obtaining laboratory ageing tests to give concordant results independent of operating conditions and apparatus is discussed and the reasons for the lack of agreement between different types of tests are briefly studied. It is indicated, however, that oils can be compared as to their life or resistance to oxidation when instead of oxidizing them all for the same time period, one employs a method wherein an oil is oxidized until it produces a definite or standard amount of some easily determined end-product, as, for instance, insoluble sludge. Such conditions are obtained by the so-called "Indiana Life Test," which is described as a new and modified procedure of the original Indiana test; this procedure

is to use 20 c.c. of oil instead of 300 c.c. as in the original test. Then the oil is also subjected to 650 c.c. of air/hr. at 200° C. The time is then noted which is necessary to produce by oxidation 15 mgm. of insoluble asphalt/gm. of oil.

The testing of ten different oils by the modified Indiana test showed that the sludging time or valuation of these oils is in a wide degree independent of the conditions of temperature and volume of air used.

Several other tests showed that in many cases the viscosity, the acid and saponification values must also be determined, besides the insolubles test. The effect of added oil-resins on the oxidation of an oil is also indicated. A. H. N.

Motor Fuels.

426. **Patents on Motor Fuel.** A. B. Doran, E. Marston, and K. Walsh. E.P. 532,867, 3.2.41. Appl. 30.5.39. Production of a motor fuel consisting of a hydrocarbon fuel and an anti-detonant comprising an anti-detonant organo-metallic compound of an unsaturated aliphatic hydrocarbon having one metallic atom in the molecule.

H. G. Schneider. U.S.P. 2,225,942, 24.12.40. Appl. 20.11.36. Preparation of a motor fuel consisting of gasoline and di*iso*propyl ketone, the latter component forming 5-50% of the fuel.

J. W. Teter. U.S.P. 2,226,787, 31.12.40. Appl. 14.7.37. Inhibition of oxidation of gasoline by incorporating therein a small proportion of a halogenated saturated cyclic alcohol.

M. M. Holm. U.S.P. 2,228,662, 14.1.41. Appl. 31.5.39. Production of a high anti-knock motor fuel comprising a fuel base consisting essentially of *iso*paraffinic motor fuel hydrocarbons and from 10 to 50% by volume of a saturated aliphatic ester of a monocarboxylic acid.

See also Abstract No. 411. H. B. M.

Lubricants and Lubrication.

427.* **Oil Flow Through Engine Bearings.** Report of the Automobile Research Committee, prepared by J. Spiers. *Instn. Aut. Engrs. J.*, January 1941, **9** (4) 7–34.—Tests were made on a 6-cyl. water-cooled petrol engine in which the front main and big-end bearings were isolated from the main lubrication system and separate external pumps substituted. Thus the effect of pressure and temperature on oil-flow could be studied. The range of clearances tested was: main bearings 0·0007–0·0055 in., big-end 0·0015–0·005 in. Variable-pressure tests were run at an oil inlet temperature of 70° C., and variable temperature tests at oil pressures corresponding to those given by the engine system under the same conditions. An S.A.E. 50 oil was used mostly, but some tests with small clearance bearings were also run with an S.A.E. 20 oil.

It was found that the rate of oil-flow was directly proportional to the effective oil pressure at the bearing and increased rapidly with speed and clearance. The increased flow at the higher speeds is shown to be due to the reduced viscosity of the oil-film consequent on increased operating temperature; the film temperature varies linearly with speed and is independent of load. The viscosity of the oil at the engine inlet bears little relation to the operating viscosity in the bearing; thus, the increased flow due to changing from S.A.E. 50 to S.A.E. 20 oil was not in proportion to the change in viscosity at the oil inlet temperature, since the operating temperature within the bearing was reduced with the lighter oil.

It is concluded that the flow of oil through engine bearings under operating conditions obeys laws approximating to those of viscous flow through an annular passage. The main factors are supply pressure, viscosity of the oil-film in the bearing and diametral clearance, although other design features will modify the total flow through the bearing. K. A.

428.* Use of Additives in Automotive Lubricants. F. L. Miller, W. C. Winning, and J. F. Kunc. *Refiner*, February 1941, **20** (2), 35. *Paper presented before American Chemical Society.*—After a general discussion on the need for using additives in lubricants, it is indicated that the principal properties which determine the suitability of petroleum oils for the lubrication of engines may be considered essentially to be: (1) viscosity and volatility; (2) viscosity-temperatures and low-temperature flow characteristics; (3) chemical stability; (4) detergent and sludge-dispersing ability; and (5) oiliness and wear characteristics.

The relative importance of these different characteristics, and the degree to which they can be modified by the use of proper additives, form the basis of this paper.

By the choice of proper crudes and by suitable selective refining, motor oils of 80–100 and even 110 V.I. can be prepared economically. It is not practical to obtain higher viscosity indices by these methods except in special cases. On the other hand, it has been found possible in recent years to improve the viscosity index materially through the use of relatively small quantities, in the order of 1–5%, of certain types of high-molecular-weight polymeric linear chain compounds, and premium-quality motor lubricants are now being made successfully by such means.

To counteract low-temperature flow troubles due to wax, pour depressants are used. The pour depressants appear to act (*a*) to keep the wax crystal small and prevent its growth, and (*b*) to prevent adsorption of the oil on the crystal. Both these functions are typically colloidal, and presumably the effectiveness of the different pour depressants depends largely on their colloidal state and behaviour, particularly at low temperatures. Reference is made to various depressants, and especially to Friedel-Crafts condensation products.

A review of the patent and other pertinent literature reveals that the classes of compounds most commonly advocated as anti-oxidants, bearing corrosion inhibitors, and metal passifiers are: (*a*) various types of phenols, (*b*) certain sulphur-bearing compounds, (*c*) numerous organic phosphites, and (*d*) certain of the amines. In a number of instances combinations of one or more of these types are mentioned. Each class is discussed separately and briefly, giving references to original publications.

Detergents and sludge-dispersing ability are next discussed. The use of fatty oils, soaps, and naphthanates for this purpose is detailed.

Except for one or two marketers who are adding compounds to their motor oils to improve oiliness, and a few others who are presumably incorporating anti-oxidants, which happen also to confer extra oiliness, the use of additives to obtain better lubrication properties has not been very extensive. Materials most frequently employed to increase oiliness and film strength contain groups commonly known as polar groups, such as those containing oxygen or phosphorous, or distinctive reactive chemical elements, such as sulphur or chlorine.

Finally a study is made of what are called " multifunctional additives."

A. H. N.

429.* Rubber in Lube Oils. L. Light. *Petroleum*, September 1940, 176.—Natural rubber and synthetic rubber-like materials have been used in the production of improved lubricating oils either in their original form or after modification. Thus rubber hydrogenated in the presence of a nickel catalyst has been incorporated in spindle oils to give products of increased viscosity.

Poly*iso*butylenes have been recommended for flattening the temperature–viscosity curve of hydrocarbon oils. The initial polymerization of the *iso*butylene was carried out by boron trifluoride and the partly polymerized olefine dissolved in oil and treated with anhydrous $AlCl_3$.

In a recent process both rubber and a polymerized olefine are used to improve a hydrocarbon lubricant, the olefine being treated in the presence of rubber.

D. L. S.

430.* Considerations in Valve Lubrication. G. F. Scherer. *Chem. Met. Eng.*, March 1940, **47** (3), 164–165.—The lubricant used in a lubricated tapered plug-cock performs a number of functions which, in order of importance, may be listed as follows: (1) It affects a plastic seal between the sliding contact surfaces of the valve to prevent leakage of the line fluid and to prevent infiltration of foreign matter between these surfaces; (2) it furnishes a fluid medium for lifting the plug from its seat, both to

provide a space for the renewal of the lubricant film and to free the plug from its seat if corroded and frozen together; (3) it effects easy operation of the valve by lubricating the sliding contact surfaces and reducing the friction between them; and (4) it provides a protection for these surfaces so that the original surface finish is not marred by corrosion which would increase the turning effort and also permit leakage.

The importance of film thickness, viscosity, adhesiveness, spreading quality, and other characteristics which are desirable in a valve lubricant are indicated.

Besides the conventional mineral oils and soaps used in compounding ordinary cup-greases, many other materials are used in the manufacture of valve lubricants. These include vegetable and animal oils, fats, waxes, asphalts, synthetic oils and waxes, graphite, resins, glycerine, alcohols, and various inert materials sometimes used for fillers. A. H. N.

431.* **Chemical-Plant Lubrication.** Anon. *Chem. Met. Eng.*, March 1940, **47** (3), 172–178.—The paper is divided into four comparatively distinct parts. The first part deals with the elements of lubrication and explains the need and theory of lubrication by elementary and mechanical concepts of the molecules of the lubricant as spheres separating the jagged surfaces of the parts lubricated.

Part II deals with the properties of lubricants. To select the right lubricant for a given job requires a knowledge of the desirable (and undesirable) properties of lubricants. In this paper the sources of lubricants are discussed—mineral, animal, vegetable and others—together with the outstanding properties of lubricants and the tests for them. Significance of viscosity, viscosity index, demulsibility, carbon residue, flash point and others are included. The tests are very briefly described.

In the third part the application of a lubricant is discussed. Boundary and fluid-film lubrication are studied, and several methods of applying lubricants in practice are described and illustrated. The ideal lubricating device should: (1) form and maintain a satisfactory lubricating film under all conditions of operation; (2) be economical in operation—feed only enough lubricant to maintain a film while the equipment is in motion—not feed while the equipment is at rest; (3) be automatic—require very little attention; (4) protect the lubricant from contamination, dust, dirt, water, etc., (5) carry away heat from bearings by a continuous flow of the lubricant; (6) be convenient to service with lubricant; (7) be rugged enough to withstand normal abuse and not readily break or become inoperative; (8) moreover, installation costs should not be too high in proportion to the benefits to be derived. Storing of lubricants is also discussed in this part.

Part IV deals with chemical factors in lubrication. In this section the use of special lubricants for special cases is discussed. In the handling of viscose rayon, especially in the metering pumps, viscose is the best lubricant. The reason is to avoid contamination of product. Handling hydrogen gas requires special technique, soap and water generally being used for lubrication. Likewise equipment for handling oxides of nitrogen is generally soap-and-water-lubricated, although mineral-oil lubrication has been successfully used in at least one installation. Solvents are quite troublesome, as it is necessary to lubricate with a material that is insoluble, yet has lubricating properties. The petroleum industry has many problems in this respect varying all the way from lube-oil pumps, which are self-lubricating, to gasoline pumps, which are often lubricated with modified castor oils. Other cases are mentioned and general principles are discussed. A. H. N.

432.* **Speciality Lubricants.** D. M. Considine. *Chem. Met. Eng.*, April 1940, **47** (4), 230–233.—The manufacture of oils and greases which contain chemical compounds to fit them for use in special services is described. The paper, however, deals mainly with processes of one particular company, and not in general.

There are three general types of treatment used in the manufacture of hypoid gear lubricants—namely, (1) lead soap, active sulphur, (2) lead soap, sulphur saponifiable, chlorine compound, and (3) organic sulphur compound, chlorinated organic compound. Processing operations at the plant are segregated into three classes, consisting of the preparation of intermediate chemicals, blending intermediates of their own preparation with those purchased from outside chemical manufacturers to produce concentrates, and manufacture of finished lubricants, inluding special greases, motor oils, and in-

dustrial lubricants. Certain of the intermediate chemicals blended in the concentrates are produced from suitable raw materials, whilst others are purchased. The operations are essentially batch, although there are features of some of the equipment which make that particular phase of the processing automatic and continuous.

Preparation of intermediates from the raw materials requires such processing as mixing and reacting at ordinary and elevated temperatures, atmospheric and vacuum distillation, dehydration, washing, and filtering. All intermediates do not require the same treatment, and many items of equipment are designed and installed for the purpose of performing various operations. These operations are described separately.

Intermediate chemicals are blended in exact proportions according to the specifications reached as a conclusion from the research findings and data. The constituents are proportioned by volume and mixed by means of a Lummus-Cornell homogenizer. When solid materials are added to the concentrates they are dissolved in suitable solvents, usually one of the other constituents, and then proportioned just as the other liquids through the electrically driven proportioning pumps. The operations of the homogenizer and pumps are described.

Manufacture of grease in the same plant is detailed. A. H. N.

433. Patents on Lubricants and Lubrication. A. J. Rudgo. E.P. 532,953, 4.2.41. Appl. 2.8.39. Preparation of lubricating materials suitable for extreme-pressure lubrication and consisting of thiophosphoryl chloride and a lubricating oil.

J. M. Musselman and H. P. Lankelma. U.S.P. 2,224,368, 10.12.40. Appl. 11.11.37. Preparation of a lubricant comprising a mineral lubricating oil and a small proportion of an alkaloid salt of an organic carboxylic acid of at least six carbon atoms.

K. Frolich. U.S.P. 2,224,541, 10.12.40. Appl. 9.6.39. Preparation of a lubricating composition composed of a viscous hydrocarbon oil and a small amount of a synthetically prepared ester having a boiling point above 150° C. of a cyclic acid and of an alcohol having not more than three hydroxyl groups.

A. J. Morway and F. L. Miller. U.S.P. 2,225,318, 17.12.40. Appl. 26.8.39. Production of a lubricating composition comprising a lubricating-oil base stock and a halogen derivative of a substantially saturated linear aliphatic hydrocarbon compound having a molecular weight above about 800 and containing at least 1% of halogen.

U. B. Bray. U.S.P. 2,225,365, 17.12.40. Appl. 18.1.37. Preparation of a mineral lubricating oil containing approximately 1·25% of freely oil-soluble metal salt of a chlorinated fatty acid. In this way ring- and valve-sticking tendencies are overcome in internal-combustion engines without appreciably increasing the viscosity of the original lubricating oil and without imparting grease-like characteristics to the oil.

U. B. Bray. U.S.P. 2,225,366, 17.12.40. Appl. 2.11.37. Preparation of a lubricant composed of approximately 97% of mineral lubricating oil and between 1% and 2% of oil-soluble soap constituent of organic acid containing 10 or more carbon atoms, and including a film-strength increasing constituent consisting of halogens, sulphur, and phosphorus.

U. B. Bray. U.S.P. 2,225,367, 17.12.40. Appl. 29.4.39. Preparation of a freely liquid lubricating oil in which is incorporated a small quantity of an oil-soluble soap of a synthetic petroleum acid. The proportion of the latter constituent is such that ring- and valve-sticking tendencies in internal-combustion engines are overcome.

S. C. Fulton. U.S.P. 2,225,430, 17.12.40. Appl. 25.6.37. Manufacture of a low-pour-point lubricating oil composed of a blend of a wax-containing petroleum lubricating oil with a minor proportion of a pour-inhibiting agent. The latter is prepared by adding to a refractory distillate from a cracking-process tar boiling above 700° F. about 5% by weight of anhydrous aluminium chloride.

M. B. Chittick. U.S.P. 2,225,684, 24.12.40. Appl. 8.8.33. Production of a solid extreme-pressure lubricant consisting of unsaturated hydrocarbon polymers and a soap.

D. E. Badertscher, F. M. Seger, and W. H. James. U.S.P. 2,226,420, 24.12.40. Appl. 3.10.39. Production of an extreme-pressure lubricant consisting of a hydrocarbon oil and a small proportion of mixed anhydrides of an alkyl thiocarbonic acid and an acid of phosphorus. The mixed anhydrides are obtained by the reaction of a halide of phosphorus with an alkali alkyl thiocarbonate.

E. V. Murphee. U.S.P. 2,227,149, 31.12.40. Appl. 23.12.37. Production of an improved lubricant for internal-combustion engines comprising a lubricating oil and a small amount of a polyvalent metal soap of acids derived from the oxidation of "sweater oil."

M. H. Arveson. U.S.P. 2,227,690, 7.1.41. Appl. 6.10.38. Preparation of a diesel-engine lubricant consisting of a paraffinic lubricating oil having a 90% distillation temperature at about 1 mm. pressure of less than 500° F., and an *iso*-olefin polymer having a 90% distillation temperature at about 1 mm. pressure of about 450–700° F.

E. R. Barnard. U.S.P. 2,227,692, 7.1.41. Appl. 19.12.39. Preparation of a diesel-engine lubricant consisting of a blend of 5–95% of a naphthenic-base mineral oil and 5–95% of an *iso*butylene polymer from which the low-boiling and high-molecular constituents have been removed.

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W. L. Steiner. U.S.P. 2,228,219, 7.1.41. Appl. 29.12.39. Preparations of a composition of matter consisting of a major proportion of a lubricant and a minor proportion of a physical solution of elemental sulphur in uncombined form dissolved in a minor proportion of a solvent which is a sulphur solvent, and at the same time is itself soluble in the lubricant.

H. G. Berger, D. E. Badertscher, and F. M. Seger. U.S.P. 2,228,252, 14.1.41. Appl. 28.6.39. Preparation of an extreme-pressure lubricant consisting of a hydrocarbon lubricating oil and a small proportion of a perchloromethyl mercaptan.

J. F. Olin and R. H. Goshorn. U.S.P. 2,228,325, 14.1.41. Appl. 27.7.37. Production of a lubricating composition consisting of a hydrocarbon oil and a small proportion of a trialkylammonium salt of an inorganic hydrohalogenic acid.

B. B. Farrington, J. O. Clayton, and J. T. Rutherford. U.S.P. 2,228,658, 14.1.41. Appl. 21.11.38. Manufacture of a composition of matter consisting of a hydrocarbon lubricating oil and a minor proportion of an alkaline-earth metal salt of a substituted acid of phosphorus containing an organic constituent.

E. W. Gardiner and G. H. Denison. U.S.P. 2,228,661, 14.1.41. Appl. 8.10.38. Preparation of a composition of matter consisting of an oil and from 0·1% to 50% by weight of an alkaline-earth metal phenate dissolved therein.

G. L. Neely and E. W. Gardiner. U.S.P. 2,228,671, 14.1.41. Appl. 25.11.38. Preparation of a lubricant consisting of a hydrocarbon oil, a metal phenate, and from 0·05% to 2% by weight of a salt of a substituted acid of phosphorus containing an organic constituent.

L. C. Brunstrum. U.S.P. 2,229,367, 21.1.41. Appl. 29.4.40. Manufacture of a grease composed of a lubricating oil and a soda soap of hydrogenated fish-oil fatty-acid pitch.

L. C. Brunstrum. U.S.P. 2,229,368, 21.1.41. Appl. 29.4.40. Preparation of a heat-resisting grease consisting of a lubricating oil, soda rosin soap, and soda soap of hydrogenated fish-oil fatty-acid pitch.

W. H. Bahlke and T. H. Rogers. U.S.P. 2,229,485, 21.1.41. Appl. 30.11.39. Method of increasing the sludge stability of a petroleum lubricating oil distillate by mixing therewith, prior to treatment with sulphuric acid, 0·1–5·0% of a heavy uncracked petroleum residue.

See also Abstract No. 425. H. B. M.

Asphalt and Bitumen.

434.* Bituminous Soil Stabilization. W. L. Campbell. *Roy. Engrs. J.*, March 1941, **55**, 89–103.—The main idea underlying soil stabilization is the retention of the moisture content of the soil within such limits as will ensure stability, the latter being determined by (*a*) internal friction, (*b*) cohesion, and (*c*) apparent cohesion. As the measurement of stability the bearing strength of the soil surface is determined by means of a cone penetrometer. (Full details of this test are given in an appendix.) The task of the stabilizer is to impose a limit to the variations that could occur in the soil mass as regards moisture content, by reason of ingress of capillary or ground-water. The bituminous stabilizer should be of such a nature that it can be dispersed throughout the soil-mass in such a way as to form automatically a series of plugs throughout the capillary structure of the soil. It has been shown in the laboratory that a soil-mix, designed in accordance with the grading and bearing-strength requirements and containing 2% by weight of stabilization oil, possesses in general adequate water resistance. The percentage of the oil is based on the mortar content of the mix. B. M. H. T.

435. Patents on Asphalt and Bitumen. Celotex Corporation. E.P. 531,690, 9.1.41. Appl. 4.7.39. Wear-resisting and resilient surface covering consisting of a number of units of fireboard the interior interstices of which are incompletely filled with bituminous material.

N.V. de Bataafsche Petroleum Maatschappij. E.P. 533,170, 7.2.41. Appl. 2.10.39. Production of unemulsified bituminous substances with improved properties, particularly as regards adhesivity and facility in spreading. The substances are mixed with small quantities of sulphuric-acid esters or arylsulphonic acid esters of lower primary aliphatic alcohols, or with substances from which these esters may be formed.

A. P. Anderson. U.S.P. 2,224,372, 10.12.40. Appl. 18.5.38. Improvement in production of asphaltic hydrocarbons from a straight-run petroleum oil containing substantial amounts of wax and asphaltic hydrocarbons by precipitation with normally gaseous hydrocarbons. By this process the resultant asphaltic hydrocarbons are free from harmful wax.

J. P. Pfeiffer. U.S.P. 2,225,570, 17.12.40. Appl. 2.10.39. Method of improving the adhesive properties of an asphaltic bitumen by combining the bitumen with a small amount of a sulpho-compound.

See also Abstract Nos. 423 and 424. H. B. M.

Special Products.

436.* Containers and Lacquers for Foodstuffs. F. D. Farrow and T. G. Green. *Chem. and Ind.*, 1941, **60**, 95–103.—The article is largely a review of lacquers used in the internal proofing of tins. Under this category is outlined the use of wax for the lining of beverage cans. Owing to the poor adhesion of wax to tin, a special lacquer has first to be applied to the tin. The comparatively low melting point of wax is a disadvantage in dealing with liquids which should be canned while hot. The wax coatings have the advantage of good proofing qualities and no tendency to contaminate flavours.

Brief mention only is made of waxed paper cartons. T. C. G. T.

437. Patents on Special Products. Agricultural and Chemical Products, Ltd. E.P. 530,624, 17.12.40. Appl. 14.6.39. Simultaneous production of higher monohydric alcohols and ethylene from gases containing olefins.

G. G. Luzzatto. E.P. 531,174, 31.12.40. Appl. 27.6.39. Manufacture of a fire-lighter having a basis of coal, coke, semi-coke, etc., provided with or possessing a proportion of bituminous substance and impregnated, coated, or intimately admixed with an oxygen-carrier.

Standard Oil Development Company. E.P. 531,233, 31.12.40. Appl. 14.7.39. Production of oxy-organic compounds by treating a hydrocarbon or mixture of hydrocarbons having less than 6 carbon atoms per molecule with a gas containing free oxygen at a temperature below the critical temperature of the hydrocarbons, and under sufficient pressure to maintain the hydrocarbons in the liquid phase in the presence of an oxidation catalyst.

N.V. de Bataafsche Petroleum Maatschappij. E.P. 531,359, 2.1.41. Appl. 19.7.39. Process for concentrating highly foaming solutions of capillary-active substances, *e.g.*, aqueous soap solutions, aqueous solutions of alkali or alkaline-earth salts of sulphuric acid esters derived from olefins or alcohols.

Standard Oil Development Company. E.P. 531,383, 2.1.41. Appl. 11.10.39. Continuous process for the reaction of tertiary-saturated hydrocarbons with olefins. An emulsion of a tertiary hydrocarbon in aliquid material capable of catalysing the reaction is mixed with a controlled quantity of a mixture of the tertiary-saturated hydrocarbon and the olefin. The resultant product is then passed through a reaction zone, and part of it removed. An amount of hydrocarbon substantially equal to the volume of olefin–tertiary hydrocarbon mixture is separated out and the remainder recycled.

General Motors Corp. E.P. 532,630, 28.1.41. Appl. 15.9.39. An improved oil filter comprising a filtering medium having incorporated therein a mixture of *para*-aminophenol, catechol, or *para*phenylenediamine for inhibiting or preventing the formation of resins and acids in the oil.

E. M. Marks and J. W. Johnson. U.S.P. 2,224,158, 10.12.40. Appl. 18.2.36. Method of lubricating Cu–Ag–Cd and Cu–Ni–Pb bearings operated at a high temperature without substantial corrosion. A hydrocarbon lubricating oil incorporating a small quantity of an aryl substituted thiourea is employed.

M. A. Dewey. U.S.P. 2,225,533, 17.12.40. Appl. 26.7.38. Preparation of a transformer oil consisting of a petroleum oil, normally subject to oxidational deterioration resulting in the formation of sludge, and about 0·3% of 2 : 6-*ditert.*-butyl-4-methylphenol and about 0·1% of diphenylamine. The addition agents are effective in combination in retarding the appearance of sludge in the oil.

T. L. Cantrell and J. O. Turner. U.S.P. 2,226,335, 24.12.40. Appl. 14.9.36. Preparation of an oil-soluble organic phosphorus compound suitable as an improvement agent for hydrocarbon oils and effective in imparting extreme pressure characteristics in such oils. The method consists in reacting an olefin and a phenol in the presence of sulphuric acid and treating at least a portion of the resultant product with phosphorus oxychloride to obtain a final product containing 1–5% of phosphorus.

W. H. King and C. Q. Sheely. U.S.P. 2,226,378, 24.12.40. Appl. 26.7.39. Production of partially oxidized products of normally liquid aliphatic hydrocarbons by introducing the hydrocarbons in vapour phase, together with an oxidizing agent, into a reaction chamber at 250–500° C. The amount of hydrocarbon in the hydrocarbon–oxygen ratio is maintained above the explosion limit, and the materials are reacted for not more than 15 sec. in the presence of benzoyl peroxide.

D. L. Wright. U.S.P. 2,228,429, 14.1.41. Appl. 20.9.38. Preparation of a pneumatic percussion-type drill lubricant having adhesive and moisture resistant characteristics. The composition consists of a major proportion of a hydrocarbon lubricating oil, 1–14% of blown rape-seed oil, and 0·1–0·5% of *iso*butylene polymer.

H. B. M.

Detonation and Engines.

438.* Diesel Engines Underground. II. Effect of Adding Exhaust Gas to Intake Air. *Report of U.S. Dept. of the Interior*, Nov. 1940.[1] L. B. Berger, M. A. Elliott, J. C. Holtz, and H. H. Screnk.—The previous report showed that ventilation must be provided to dilute and remove the harmful constituents of the exhaust from diesel engines used in underground working places. The results then reported applied to the operation of engines in normal air, but the possibility of an engine operating in an atmosphere containing its own exhaust gas must be considered. Tests were made on a four-cylinder engine of 70 b.h.p., using a fuel of 50 cetane number; part of the exhaust gas was diverted and mixed with the intake air.

It was found that the concentration of CO in the exhaust was always greater when exhaust gas was present in the intake than when the engine was operated in normal air at the same fuel–air ratio. The increase was most apparent at or near full load; it could not be attributed to CO added to the intake by the exhaust gas. It is suggested that the decrease in oxygen concentration was the fundamental cause.

The concentration of oxides of nitrogen in the exhaust gas decreased as exhaust gas was added to the intake. There was no marked effect on the concentration of aldehydes.

It is concluded that no unreasonable increase in ventilation would be required to maintain a satisfactory working environment if the CO_2 in the atmosphere were not greater than 1%; the underground atmosphere should be analysed frequently to ensure satisfying conditions. Diesel engines should be prohibited where the ventilation is locally inadequate, and "short-circuiting" of the exhaust between the exhaust outlet and air intake of the engine should be avoided. K. A.

439.* Engine Bearing Temperatures (Third Report—Bench Tests). Report of the Automobile Research Committee, prepared by J. Spiers. *Instn. Aut. Engrs. J.*, February 1941, **9** (5), 7–39.—This report deals mainly with the effects of diametral clearance on bearing temperatures at rubbing speeds up to 2350 ft./min. Details of the engine and bearings used are given in Abstract No. 427. Bearing temperatures were measured by means of thermocouples connected to slip-rings on the crankshaft. With clearances of the order of 0·0005 in. oil inlet temperature had little, if any, effect on the bearing temperature, and at high speeds such a bearing would tend to seize. With clearances up to about 0·0015 in. oil cooling as a means of reducing bearing temperatures appears to be of little value. With clearances above 0·0035 in., although 60% or more of any oil inlet temperature reduction is passed on, the actual bearing temperatures are scarcely high enough to justify oil cooling on this account in an engine of the size tested.

The influence of oil pressure on bearing temperature was small, as was also the effect of water-jacket temperature. It is considered that efficient ventilation of the crankcase interior by cool air might have a beneficial effect on big-end temperatures. Motoring tests showed that bearing temperatures were almost independent of load. The addition of 1% methyl-dichlorstearate to the oil produced no measurable differences in temperature throughout the speed range, as compared with the untreated oil; it is inferred that heat generation in the bearings is entirely due to viscous friction, *i.e.*, lubrication is of the fully fluid type.

The tests confirmed that the main factors determining engine bearing temperatures are diametral clearance, oil viscosity, and speed. In this respect the use of light oils of high viscosity index is advocated. Bearing temperatures rise linearly with speed, and increasing speed tends to raise main bearing temperatures more than big-end temperatures. K. A.

440. Patents on Detonation and Engines. I. G. Farbenindustrie A.-G. E.P. 532,424, 23.1.41. Appl. 30.8.39. Production of non-knocking motor fuels by catalytically cracking hydrocarbons obtained from carbon monoxide by reaction with hydrogen, mixed with a paraffinic-base petroleum oil or fractions thereof.

H. Kaufmann. U.S.P. 2,228,118, 7.1.41. Appl. 3.5.39. Production of a non-knocking motor fuel by heating to cracking temperature a mixture of a normally

[1] See also Abstract No. 1427, Oct. 1940.

non-gaseous reduction product of carbon monoxide with a normally non-gaseous hydrocarbon product, in the presence of a stationarily arranged catalyst having a splitting action and of a non-oxidizing gas under a pressure above 350 atmospheres.
H. B. M.

Coal and Shale.

441.* Technical Study of Transvaal Torbanite. S. L. Neppe. *J. Inst. Petrol.*, 1941, **27** (208), 31–65.—Torbanite consists of mineral matter which is essentially inherent with the organic constituents which make up the volatile and fixed carbon. The different grades of Transvaal torbanite may be considered as having a common origin in one parent substance of high fuel ratio. There is little difference between the ultimate products of deterioration of torbanite, irrespective of the quality of the original minerals. It is probable that during the stages of deterioration depolymerization processes play a big part in the chemistry of the kerogen molecules, such deterioration offering some striking parallelisms to certain cracking reactions. In both processes hydrogen is mainly removed as a result of which the carbon contents of the volatiles show a steady increase up to a limit. Beyond this point in both cases carbon is separated. This theory of the deterioration of torbanite is substantiated by additional interesting facts observed and recorded by the author. B. M. H. T.

Economics and Statistics.

442.* Opportunities in the Petroleum Industry. Anon. *Chem. Met. Eng.*, June 1940, **47** (6), 416–422.—The paper is in two parts: the first deals with the petroleum industry as a whole and its structure; the second with the opportunities afforded to the chemical engineer in the industry. The treatment is of the American petroleum industry. A. H. N.

BOOK REVIEW.

U.O.P. Laboratory Test Methods for Petroleum and its Products. Published by the Universal Oil Products Incorporated, 310 South Michigan Avenue, Chicago. 1940. Price $3.

The first edition of this book was issued in 1937, and was intended particularly for use by the refiner with limited personnel and literature facilities to supplement the A.S.T.M. methods of test. The revised edition is issued in loose-leaf form of binding, and index tabs are provided for the various sections, and it is stated that as revised methods become available they will be distributed without charge to holders of the book.

A number of the methods given in the earlier edition have been eliminated, and there has been a thorough revision of the methods which have been retained; the methods given have been either developed by the U.O.P. laboratories, or tested out by them.

The following will illustrate some of the types of analytical procedures covered:

Salt content of charging stocks; carbon and hydrogen analysis, by a semi-microscopic method; volumetric determination of sulphur; molecular weight of petroleum; nitrogen in petroleum; laboratory preparation of asphalts; routine high vacuum distillation of heavy oils; analysis of gasolines for paraffin, olefine, naphthenic and aromatic content.

A large section of the book deals with the analysis of gases, including the determination of gaseous olefines by catalytic hydrogenation and the fractional distillation of C_4 and C_5 hydrocarbons.

Under fuel oils a method is given for the determination of Redwood Admiralty viscosity at 32° F., and this does not appear to be in accord in all details with the standard Admiralty procedure.

The method for the hydrocarbon analysis of gasolines is based on the determination of the percentage of olefines from the bromine number and the molecular weight, and the aromatic hydrocarbons by specific dispersion, and the naphthene/paraffin ratio from the refractive index and by calculation. Naturally in a book of this kind no evidence is given of the accuracy of the methods employed or of the justification for using refractive index and specific dispersion methods in preference to the much simpler aniline-point method.

An index is provided, which is very complete.

By reason of the fact that it collects together the methods of analysis which have been tried out and which are not included in the standard methods of testing, U.O.P. Laboratory Test Methods will be found to be of considerable value to all laboratories engaged in the testing of petroleum products. F. H. GARNER.

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Geology and Development.

443.* Hawkins is New Woodbine Field in East Texas Area. H. L. Flood. *Petrol. Engr*, Feb. 1941, **12** (5), 25.—The Hawkins discovery well was completed in November 1940, and the southern limit of the field now seems to have been partly defined. The structure is stated to be a dome, elongated in a north–south direction. Crude is obtained from the Woodbine at depths of 3924–4490 ft. below sea-level. The oil differs considerably from the Woodbine oil found elsewhere. One well blew out with high-pressure gas from the Sub-Clarksville, which overlies the Woodbine, at a depth of 4360 ft.

A table gives the depths of various horizons in the nine wells drilled to date.

G. D. H.

444.* Dyersdale may Broaden Frio Trend Play in Coastal Texas. F. L. Singleton. *Oil Gas J.*, 20.2.41, **39** (41), 22.—The Dyersdale field lies 13 ml. north-east of Houston, and is one of the few shallow discoveries to be made on the upper Texas Gulf Coast in several years. It is the most northerly field to produce from the Marginula–Frio sand. The area was worked over by reflection seismograph and soil surveying, and in September 1940 the discovery well was brought in at 4068–4073 ft. Thirteen producing wells have now been completed. Some believe that it is a salt structure.

After several unsuccessful wells, oil was found in the Mount Houston area quite near to Dyersdale. Much gas and a little distillate are obtained from the Miocene at a depth of 3465–3486 ft. Mount Houston is believed to be separated from Dyersdale by a major fault. There is promise of production from the Jackson in this area.

Other similar structures probably exist along this trend, and several wildcats have been located. Interest is being revived in old prospects as a result of this shallow development.

G. D. H.

445.* New Venezuelan Field Indicated by Sinclair Well in Monagas. J. P. O'Donnell, *Oil Gas J.*, 20.2.41, **39** (41), 24.—1 Santa Barbara in the State of Monagas has found production, estimated at 4000 brl./day according to a drill-stem test. It lies about 10 ml. west of the Jusepin field, and on the south flank of a dome revealed by the torsion balance, and indicated to be oil-bearing by soil surveying. The well is 4321 ft. deep and the sand section 99 ft. thick.

A little earlier 1 Santa Rosa was successfully completed in Anzoategui, 10 ml. north of the San Joaquin field.

A map shows the oil-fields, exploratory wells, refineries, and pipe-lines.

G. D. H.

446.* Well Logs and Field Data of Active Oil Areas—South Central Illinois. Anon. *Oil Gas J.*, 20.2.41, **39** (41), 58.—This area came to the fore with the discovery of the Centralia, Salem, and Louden fields. Oil is obtained chiefly from Pennsylvanian sands, the Palestine sand, Waltersburg sand, Tar Springs, Hardinsburg sand, Cypress sand, Paint Creek stray sand, Bethel sand (Benoist), Aux Vases sand, Rosiclare sand, Fredonia lime (McClosky), St. Louis lime, and Devonian lime. Where productive, these horizons are practically all above 3000 ft.

Up to the end of Lower Mississippian times more or less blanket deposits were formed, first of sand and then of lime, over much of southern Illinois. From time to time they were eroded, and they are productive locally at well-defined unconformities. At present the Trenton is productive, with minor exceptions, only on the western rim of the basin. The Devonian has been proved north-north-west from Centralia and Salem, and the Salem and St. Louis are productive in the eastern part of this belt. The McClosky is important for production in a triangular area north-east from Centralia.

The area was submerged and the Chester series deposited, of which Benoist and Aux Vases production is most widespread. After the Chester the main structural trends were developed, and chief among these is a series of north–south belts parallel to the Du Quoin anticline, north-west–south-east trends in the west of the area and north-east–south-west trends in the east. Production is mainly from the intersections of these trends.

Pennsylvanian seas covered the Chester, and local structures were developed during

this and later periods. Some of the structures reflect Chester structures, but others do not, a consequence which has led to many disappointments.

Production per acre is relatively low from individual sands, but many fields produce from several sands, and thus 15,000–20,000 brl./acre may be obtained in the richer pools.

It is possible that many small pools remain to be discovered. The Devonian has not been adequately tested in any part of the basin south and east of Salem. The Trenton has been tested only at Centralia, and there with poor results. The St. Peter has not yet given indications of commercial production. G. D. H.

447.* Illinois Anticipates a Good Year Despite Production Decline. H. F. Simons. *Oil Gas J.*, 27.2.41, **39** (42), 36.—The Illinois daily production in Jan. 1941 was nearly 50,000 brl. or 13·8% below that for Jan. 1940. However, more wells were completed in Jan. 1941 than in the corresponding period of last year. The Trenton at Salem has just been found to be productive, but the size of the wells and the cost of development are making operators cautious. So far all the Trenton tests have been deepening jobs. Numerous small fields were discovered in 1940.

The relationship between the number of wells and production is discussed. A curve gives the production/day for 1940, and pipe-line runs are compared for 1st Jan. 1940 and 1st Jan. 1941.

50% of the development is in the south-east of the State. The Louden pool is practically completely developed. Hoodville is the most outstanding of the new fields, and gives 400-brl. wells from the Benoist and Aux Vases. Mount Carmel yields oil from several zones. At Calvin oil is being sought in Chester sands, the McClosky lime, and some Pennsylvanian sands. Several wildcats are showing promise, and some new fields have been opened this year. G. D. H.

448.* New Mexico Drilling Activity Centres on Maljamar Area. D. H. Stormont. *Oil Gas J.*, 27.2.41, **39** (42), 42.—Oil was first discovered in the Artesia–Maljamar area in 1923, but development was never strong. Since 1936, however, there has been an increase in activity, and the production has risen from 2,202,411 brl. in 1938 to 5,318,925 brl. in 1940. The oil is obtained largely from the Artesia sand-zone, the Grayburg, Jackson, and Maljamar lime-pays. Much of the present activity is development of the shallower sand-pays. The producing horizons of this general area are all believed to be found in the San Andrea lime of the Permian.

The main structural feature is a lime-high plunging from the west. Minor features on it are thought to be roughly at right angles to the main high, and to account in part for the oil and gas accumulation in the sand-fields flanking the main uplift, although cementation and lenticularity probably afford the chief control. Production has been found along the high for 20 ml., although not continuously, with an average width of ½–1 ml. On the south flank of the high the sand pays are thought to be shoreline deposits, and on the north lagoonal.

At Maljamar early production was from a sandy lime at 4100 ft., but now the principal development is in a 3900-ft. sand. There is also oil at 2400 ft. In the Grayburg-Jackson area development of the main 3900-ft. lime- and sand-pays was likewise intensified in 1940.

In Eddy county three new oil-producing areas were added last year. Dayton gives oil from a sand at 4030 ft. At Barber, east of Getty, oil is obtained at 1600 ft. 5½ ml. north of the Jackson area, 1 Etz was brought in as a small pumper at 3200 ft. G. D. H.

449.* Peru. Anon. *Oil Gas J.*, 27.2.41, **39** (42), 55.—In 1940 Peru's production of 12,127,135 brl. was 10% below the 1939 figure. It came mainly from the established fields: Zorritos, 730,000 brl., Lobitos, 2,455,504 brl., and La Brea-Parinas, 9,626,831 brl. The Rio Brava pool was opened in the north of the La Brea-Parinas area, giving 1072 brl./day from a depth of 2375 ft. A deep test is drilling in the Cretaceous at 9200 ft.

Apparently there is little activity in the Pirin field of the Lake Titicaca area. Five wells have now been drilled at Agua Caliente, where the crude is accompanied by little gas, and is seemingly under hydrostatic pressure. Its temperature is 165° F. G. D. H.

450. The Lloydminster Gas and Oil Area, Alberta and Saskatchewan. G. S. Hume and C. O. Hage. *Canada Dept. Mines and Resources. Geological Survey Paper* 40-11, 1940.—The town of Lloydminster is situated on the fourth meridian, the dividing line between Alberta and Saskatchewan, and about 24 miles south of North Saskatchewan River. The area first came into prominence in 1934, when Lloydminster No. 1 well was completed and a measured flow of 16,750 M. cub. ft. of gas was obtained at a pressure of 565 lb.

This report gives details of wells drilled and indicates the possible relation of structure to production. In addition, analyses of gas and petroleum are quoted and logs of the various wells reproduced in tabular form. Summarily, it would appear that, with the exception of Lloydminster No. 1 well, most of the gas and oil occurs in sands at or just below the top of the Lower Cretaceous sediments. Most of the wells give an initial pressure slightly greater than 400 lb. from a depth of approximately 1700 ft.

Hitherto no continuous production tests have been made of any of the wells, and it is not therefore known whether oil can be produced without accompanying water. There is relatively small difference in specific gravity between the heavy oil and water, and consequently separation between oil and water in the sands may not be very clearly defined.

Nevertheless the fact remains that gas and oil occur in the Lloydminster area in what appears to be a structure of low relief. The significance of this as an indication of what may eventually be expected from the large area included within central eastern Alberta and western Saskatchewan should not be under-estimated.

H. B. M.

451. Structure and Oil Prospects of the Foothills of Alberta between Highwood and Bow Rivers. G. S. Hume. *Canada Dept. Mines and Resources. Geological Survey Paper* 40–8, 1940.—In 1924 natural gas was discovered in Turner Valley at the eastern edge of the foothills, and in 1936 crude oil was found on the west flank of the same field. By 1939, as a result of these discoveries, exploration had led to the drilling of over 200 wells into the Palæozoic limestone at depths ranging from approximately 3500 ft. to approximately 9700 ft. In addition, other foothill structures had been subjected to systematic testing.

Up to the present, however, other structures have not been productive, and failure of a well in the Jumpingpound area, 22 miles west of Calgary, to reach the Palæozoic limestone led to a study of data collected during the course of field work. This report embodies the results of this study and illustrates structure interpretations by means of six geological cross-sections.

The conclusion is reached that in relation to oil and gas prospects the foothill structures can be divided into two types: folds like that of Turner Valley, which are anticlinal at surface and involve the Palæozoic limestone at depth; and folds like that of the Jumpingpound area, which are equally anticlinal at surface but which do not involve the limestone at depth. Folds of both types are cut off on the east flank by overthrust faults. In Turner Valley Palæozoic limestone occurs in the fold above the fault, but in the Jumpingpound area it does not.

The productive closure in the oil and gas area of Turner Valley is 4893 ft. between the highest gas-well in which the gas is at 786 ft. above sea level, and the lowest crude-oil well in which the oil comes from 4107 ft. below sea level from the same horizon as the gas. Approximately 2000 ft. of the closure holds oil, and the remainder gas. The huge productive closure and the amount of oil and gas in the Turner Valley field suggest that source materials must have been abundant and rich. The author is, therefore, of the opinion that if other structures exist with conditions as favourable as those obtaining at Turner Valley, they offer excellent prospects for oil and gas.

H. B. M.

Drilling.

452.* Detailed Drilling Studies. H. F. Simons. *Oil Gas J.*, 7.11.40, **39** (26), 50–52.—The paper deals in particular with the Cumberland field, which is deep enough to permit drilling studies to be made and at the same time not so deep that drilling is complicated by this factor. Production in the field is obtained from the Bromide sand topped at about 4800 ft., although one well has been drilled deeper and then plugged back.

An opportunity to determine the relative efficiency and cost of different types of rotary rigs is presented by the Cumberland pool. At the present time electric, mechanical, and steam rigs are running in the field, and the Pure Oil Co. is compiling data to determine the relative merits of each type in a field where gas and water are available. Water, suitable for use in boilers with only light treatment, may be obtained from the Washita River, which runs through the heart of the field. Wells on production now provide sufficient gas for fuel if most of the rigs use internal-combustion engines.

One of the outstanding features of the rotary rigs at Cumberland is the completeness and thoroughness with which they are rigged up for drilling the 5000-ft. holes. This is due to the time which must be spent drilling, approximately 60 days being required to complete a well. This is based on the last five completions in the field. Modern methods and equipment are also noticeable, and particularly outstanding are the instruments for obtaining fundamental data. By visiting the rigs in the field, practically every method for determining drilling time, rotary speed, torque weight on bit, and pump pressure may be seen.

Details of the rigs, of their operations, and of difficulties and mud troubles encountered are given. A. H. N.

453.* 2600 ft. of Cemented Tubing Removed. N. Williams. *Oil Gas J.*, 21.11.40, **39** (28), 32.—The first step in the fishing job was to pull that part of the tubing string above the top of the cement. As the height of the cement was not known, a series of inside cuts were made at approximately 1000-ft. intervals, up the hole, starting about 200 ft. from bottom, until the tubing was found free, which was at approximately 5700 ft. The free section was then pulled. This done, the job called for washing down over the outside of the tubing through the cement, and then cutting out, with inside cutting tool, as long sections as possible as the hole was washed down.

For washing down over the 2-in. tubing, 4-in. flush-joint pipe was used. This was run on 2½-in. drill-pipe. A rotary shoe was run on the bottom of the 4-in. pipe to cut the cement. In the first 600–700 ft., down to about 6300 ft., the cement, which there had not set up so well, was soft, and the tubing was washed over without great difficulty, and then cut and pulled. Very hard cement was then encountered, and from then on the job became slow and tedious.

In the hard cement trouble was experienced owing to the rotary shoes splitting up. Sometimes large pieces and strips would be left 6–8 ft. up in the hole. On one occasion a slab 13 in. long and 3 in. wide broke off and was lost in the hole. Frequently not more than a few feet could be made until the shoe started to split, rendering it unusable. The longest section of tubing washed over in any one trip through the hard cement was between 300 and 400 ft. long.

Best results and longest service were obtained with the use of a 3-tooth shoe, with teeth about ½-in long. After the first few trips this type of shoe was run exclusively.

Details of incidental operations, of cleaning, etc., are also given. A. H. N.

454.* Effects of Different Properties of Rotary Drilling Fluids. Part 2. H. F. Simons. *Oil Gas J.*, 21.11.40, **39** (28), 46. Control of the wall-building property is what is generally sought when viscosity of the mud is increased. Viscosity is often a poor index of the quality and performance of the mud, factors which cause the viscosity being more important. This is particularly true of the wall-building properties.

A flocculated mud will have an extremely high viscosity—so high, in fact, that the mud will not flow down the ditch. Yet it has very poor wall-building qualities, due to the fact that larger clots, or coagulates, cannot form an impervious sheath on the wall of the hole. The flocculated mud often builds up a very thick filter cake on the walls of the hole, and trouble may ensue.

A dispersed colloidal mixture will cause a thin impervious layer of mud to be deposited on the wall of the hole and will shut off the water from the formation. This is mainly due to the fact that water in the mud is absorbed on the outside of the clay particles and there is a firmer attachment between the water and smaller particles.

Elevated temperatures encountered in wells greatly affect the plastering properties of muds, some muds showing a minimum viscosity at one temperature and others at another temperature. Different densities of the same mud reacted differently to temperature. The filtration of mud is primarily affected by the amount and nature

of the solids present, degree of dispersion of solids, distribution of particle size, degree of hydration, and presence of dispersing or agglomerating agents. In general, preponderance of highly hydrated colloidal material and presence of a dispersing agent are conducive to the lowest rate of filtration.

On deep wells it will sometimes be impossible to break circulation following the running of casing, due to high gel strength of the mud. This is generally overcome by circulating some gelled fluid out of the hole by starting the pumps at intermediate points while running casing. Viscosity of the mud coming from the hole will be much higher following a trip than just before a trip was made, as mud in the hole has gelled, and stirring will be required to break up the gel. In many cases chemical treatment to reduce the viscosity will be necessary. Gelling of mud in the pits serves no useful purpose, and can be prevented by light agitation with the mud-guns while the trip is being made. Thixotropy is discussed in this connection.

Violent agitation by jetting or gunning the mud will increase its stability. Chemical treatment may either increase or decrease the stability, depending on the treatment. Presence of salt generally decreases stability, whereas bentonite greatly increases it, particularly if the mud is kept slightly alkaline. Salinity, alkalinity, and acidity of muds are briefly studied. A. H. N.

455.* Portable Spudders Used for Deepening Wells. H. F. Simons. *Oil Gas J.*, 2.3.41, **39** (46), 198.—The spudding machines have three advantages: small moving expense, very little rigging-up time, and low operating costs. The rotaries take from 18 to 24 hr. to rig up on a deepening job; the cost of moving drill-pipe and machinery is an important item, and the labour and bit costs increase the total bill.

The deepening of the wells equipped with 4½-in. casing would be extremely hazardous, as the smallest drill-pipe commonly used (3½-in.) does not permit sufficient clearance for efficient operation. Smaller sizes of pipe could be obtained, but their cost for a limited amount of work would be excessive. Holes equipped with larger casing present no obstacle to rotary drilling from this viewpoint.

For deepening the wells, both the horizontal-beam type and the oscillating-type spudders have been used; several portable standard rig-fronts have also been at work in the field under study. In recent months some regular standard rigs have been brought into the pool. The time required to deepen the wells depends to a great extent on the efficiency of the spudder used. Spudders which are easily controlled, which have a good motion, and can hoist and lower the tools and bailer rapidly, have an advantage. The better spudders are also very easy on a drilling line, and can also make hole faster, as they have a better motion.

The modern spudders possess a distinct advantage when it comes to handling tubing, casing, and liners. Because they have multiple-speed drums, they resemble a rotary hoist, and in most cases can run casing in approximately the same time. A saving of 5 hr. is made with the better spudding machines over those not so well designed for the running of casing and tubular equipment.

With a good machine and a good crew, it is possible to complete a deepening job in less than 28 days. This was done on one of the early wells in the field, with 50 hr. of that time being lost due to a fishing job and a fire. The spudder used was of the oscillating type. As the drilling crews become more familiar with the formations and conditions encountered, this time will be reduced.

Details are given of the equipment used, of completion practice, of cementing jobs, and of other incidental operations. A. H. N.

456.* Heaving Shale Problems. H. H. Power and C. R. Houssiere, Jr. *Oil Wkly*, 3.3.41, **100** (13), 10–14. *Paper Presented Before American Petroleum Institute.*—Great pressures are encountered in deep wells, particularly in wells located on the steeply plunging flanks of salt-dome structures. It has been suggested that gliding or slipping of these steeply tilted beds is a major cause of the movement of shales into bore-holes. It has also been noted that shales which contain bentonite absorb water from drilling fluids, swell, and thereby develop pressure which squeezes or " heaves " the shale into a well.

Some operators have reported that certain shales contain large volumes of gas under extremely high pressure. Pressure relief provided by the bore-hole allows such gas-saturated shales to be blown into the hole with drastic consequences. Other operators

have described a so-called plastic flow at considerable depth. They have postulated one essential difference between a shale which flowed plastically and one which swelled due to hydration. As the plastic flow continued, its fluidity was thought to increase, and flow became progressively worse. Artificial causes are also discussed, such as the "swabbing action" incidental to removing drill-pipe. After giving the types of heaving shales in detail, each of the above causes of heaving is further discussed separately.

The methods used in combating heaving shales are reviewed. As a general consideration, the best proportions between hole-diameter and drill-pipe should be determined and maintained. Danger zones should be recognized in advance. For instance, in one field it was considered best practice to keep a close watch for calcite crystals, checking with palæontology, and to bottom the hole immediately upon the establishment of the presence of calcite, and/or "vicksburg."

Mechanical methods for keeping the water from muds off the shale have not been developed. It does not appear likely that any practical equipment will be developed to accomplish this purpose. On the other hand, the mechanical restraint of swelling shale seems impractical.

Mud weight appears to be an important physical property of drilling fluids up to a certain critical value, beyond which other properties may become of greater significance. Generally speaking, high-weight muds provide a high hydrostatic head, which may oppose shear of the shale. They may also assist in controlling high gas pressures. Fundamentally, the mud used to combat heaving shale should have the following properties: (1) inert in relation to its effect on the shale and consequent heaving; (2) capacity to build thin, impervious walls rapidly, in order to seal off the formations from penetrating fluids—in other words, the filtration values of the mud sheath should be low; in some cases special emphasis may be laid on extra mechanical strength; (3) satisfactory viscosity, gel-strength, and gel-rate; (4) capacity to reduce the tendency of ion exchange between the mud and the formation.

A research programme is outlined for tackling the problem. A. H. N.

457.* Drilling with Water-Tube Boilers and Full Condensing Operation. Anon. *Petrol. World*. February 1941, **38** (2), 18–22.—The use of marine-type water-tube boilers for drilling purposes in California is described. Of particular interest is the fact that this departure from orthodox steam practice comes at a time when combustion-engine outfits are forging ahead rapidly, thanks to the development of hydraulic torque converters, hydraulic couplings, improved clutches, transmissions, etc.

Flow-sheets and photographs illustrate the plant. The power-plant, the cost of which is said to be comparable to or lower than conventional plants of modern design, centres around two Foster Wheeler boilers, each built to deliver 17,500 lb./hr. of 350-lb. steam at 550° F. (114° superheat). The A.S.M.E. nominal rating based on heating surface alone is 175 boiler horse-power, or the equivalent of 5630 lb./hr. under the pressure and temperature specified above. Thus it is seen that the guaranteed capacity is 311% of rating, and it is possible that considerable reserve is still available.

Structurally the boilers are portable, skid-mounted adaptation of the marine-type steam generators currently being installed in naval and cargo vessels built for high speed and economy.

With an over-all height of 13 ft. and width of 8 ft., the compactness of these boilers is surprising, particularly when it is considered that they contain about 40% more heating surface than conventional boilers outweighing them by approximately 25%. The extreme effectiveness of this heating surface is emphasized by the fact that full-load performance provides a heat-transfer rate of 9450 Btu./hr./sq. ft., compared with a fair average of about 5000–6000 in conventional practice. The superheater and burner designs are briefly described.

All exhaust steam is conserved (including that from the feed-pumps) and returned from the rig through 8-in. lines equipped with vapour-type oil scrubbers to the condenser. The surface-type two-pass closed condenser is mounted directly on the horizontal feedwater tank, which, with the necessary pumps and controls, comprises another single portable skid-mounted unit. Additional protection from oil contamination is furnished by a filtering grease extractor on the feed-water supply line to the boilers. Condensing and cooling systems are described in some detail and feed-water treatment methods are mentioned.

Amongst the advantages of the plant studied are dependability and safety. The chief disadvantage is the necessity of cooling water for condensing and cooling exhaust steam which would be felt in localities where water is scarce. A. H. N.

458.* Few Injuries from Mechanical Failures (Safety in Drilling Operations). Anon. *Petrol. World*. February 1941, **38** (2), 38.—Of 250 injuries occurring to member-company employees during 1940, and which were studied and analyzed by the California Petroleum Safety Board, Inc., 234 were caused by errors by the men, and only sixteen by mechanical failures. Three things immediately became apparent: mechanical equipment and mechanical safeguarding have reached a point of near perfection, and no matter how much more effort is expended on mechanical safeguards, only a minor percentage of injuries will be affected; also, as is the case in everything else, the human element is the thing that has to be reckoned with.

These figures—and others—which show that of all injuries in the oil industry, 85% are caused from human errors of judgment, inefficiency, or carelessness, point to the need for safety education. They show that the men, even though protected by the best mechanical safeguards and using the newest and most improved equipment, will be injured unless they themselves know how to carry out their jobs safely, alertly, and efficiently. Examples are given of the frequently occurring accidents—those of crushed feet and toes and of eye troubles—being minimized by co-operative and educational methods.

The accident record of the member-companies of the California Petroleum Safety Board as a whole for 1940 is declared to compare very favourably with the records of the major company group and the oil industry in general. One member-company, for example, drilled fifteen wells during 1940, and experienced a total of only seven days' lost time because of injuries to workers. The same company carried on all production activities involving the handling of 77 producing wells without a single lost-time accident to any of the producing department employees. Another company drilled eleven wells last year without a single lost-time injury to any of its employees, and at the same time handled 40 producing wells without a day lost because of an accident on the job.

One of the most significant results of the year for members of the California Petroleum Safety Board was that there were no cases of infection from cuts or minor wounds, which fact is significant because it shows the attitude of the men themselves. Minor cuts can be disregarded, thereby becoming focal points of infection, or they can be treated immediately, thus being rendered harmless. The man himself makes the determination, so that when there are no infections it indicates that the men have a definite interest in their own safety.

The interest instilled in the men themselves is the reason for the Safety Board record, which compares favourably with major-oil-company records, although the California Petroleum Safety Board has been in existence for but 4 years, and most of the major oil companies have carried on safety programmes for more than 20 years. A. H. N.

459.* New Portable Derrick. W. M. Greenfield. *Petrol. World*, February 1941, **38** (2), 42.—The derrick is designed for a gross capacity of 100,000 lb. when extended to its full height of 84 ft. It is of the telescoping open-face type, made in two sections capable of being extended and locked in an 84-ft. and in a 50-ft. position (the latter position for extremely heavy work). The front legs in both sections are constructed of 5 by 5 by 5/16 silicon steel angles, and the rear legs of 3½ by 3½ by 5/16 silicon steel angles. Interior bracing is of structural steel shapes. Levelling screws are used in the two front legs of the derrick. The back legs are supported by a mounting bracket on the truck, and the truck is supported underneath by legs with levelling screws.

The crown block, consisting of four 18-in. roller bearing sheaves, is built in an integral part of the derrick. The tubing-board is adjustable for height and has a capacity of 6500 ft. of 2½-in. upset tubing, racked in 60-ft. doubles. Space is also available for hanging rods in the derrick at the same time. The tubing-block and lines are strung up permanently and ready for use at all times. The same is true of the sand-line on the bailing drums.

After the unit is backed up to the well to be serviced, a hose is unreeled and connected to the dry gas-line for motor fuel.

The derrick is raised to a vertical position by means of twin screws operated by two ball-bearing bronze-alloy drive-nuts, which in turn are operated from a separate power take-off from the truck engine. The vertical position of the derrick is then ascertained by a plumb-bob arrangement mounted on the leg of the lower section. When the derrick is 4° off vertical, towards well centre, the four levelling screws are tightened until snug, and the second, or upper, section is then ready to raise.

The second section of the derrick is extended by means of a ¾-in. cable operated by a separate winch mounted on the side of the truck. After the section is raised it is locked by means of a pawl-and-lug mechanism operated from the ground. The operator does the complete erection of the derrick from one place by the truck.

A. H. N.

460.* Speed of Rotation in Rotary Drilling. R. W. Marshall. *Petrol. World*, February 1941, **38** (2), 56. *Paper Presented Before American Petroleum Institute.*—This short discourse outlines early tests to determine the optimum values of rotating speeds. Speeds between 300 and 600 r.p.m. are termed high speeds.

The present maximum speed that appears to be in use is 450 r.p.m. This maximum speed is applied in certain areas where the material is sandy shale and shale, and from a point below the surface casing at approximately 2000 ft. to a depth of approximately 6500 ft.

There are two reasons why this maximum speed has not been continued to great depths as regular practice. First, the drill-pipe at greater depth becomes more flexible, and therefore cannot be rotated safely at excessive speeds. Second, the formation being drilled becomes harder in character and is not so well suited to this maximum speed.

Tests made in limestone formation at various depths showed that speeds above 150 r.p.m. were destructive to drill-pipe and that faster penetration was possible at the lower rotating speeds of 80–100 r.p.m. This same condition will apply to some extent in any hard formation where bouncing is in evidence.

In some areas the use of rotary speeds of 175–300 r.p.m. is everyday routine, and in all cases they are used in conjunction with larger pumps and with bits that will readily clean. Bits have been so improved recently that bearing trouble is infrequent. This speed, together with limited, controlled weight on the bit, has rendered possible the drilling of straight holes with greater speed and economy. A. H. N.

461. Instruments for Logging and Sampling Oil and Gas Wells while Drilling. J. T. Hayward and L. M. Swift, *Instruments*, 1940, **13** (8), 155.—The " Bavoid Well Logging Service " is described. Twenty instruments are mounted in a trailer, and taken to the well, the necessary power for operating the equipment being obtained from the rig. The essential principle of the equipment is that a sample of the mud which has been flowing past the bit as it penetrated some known depth is abstracted from the mud return line and submitted to analysis for gas (by hot wire detector), oil (by fluorescence), and salt (by electrical conductivity). The equipment also provides depth and drilling-rate measurement, and the method of assuring that the sample of mud tested corresponds to the depth allocated to it is described. The principle would be vitiated if there should be an inflow into the mud from the surrounding strata, but this is stated to occur only rarely. Equipment for core analysis and mud testing is also included. P. D.

462. Patents on Drilling. A. Boynton. U.S.P. 2,232,688, 25.2.41. Appl. 28.11.38. Cement dump-bailer made of a tubular shell, a comparatively thin disc closing the lower end and an arcuate cutter which can slide within the shell.

A. J. Penick and K. T. Penick. U.S.P. 2,232,844, 25.2.41. Appl. 27.9.37. Casing and tubing-head assembly with an annular, resilient and flexible sealing means with a reserve supply to be screwed in when this seal wears out to an appreciable extent.

C. K. Stillwagon. U.S.P. 2,232,890, 25.2.41. Appl. 5.4.40. Derrick elevator in the form of a car running on a track attached to the side of the derrick.

W. S. Jones and C. E. Munn. U.S.P. 2,232,949, 25.2.41. Appl. 29.8.38. Overshot fishing tool with slips and packing means.

W. T. Caldwell. U.S.P. 2,232,995, 25.2.41. Appl. 25.2.41. Drilling apparatus of the rotary type whereby the drill-pipe is fed by a pressure actuated mechanism.

T. R. Alley. U.S.P. 2,233,041, 25.2.41. Appl. 14.9.39. Blowout preventer with a sealing means around a pipe being actuated by well-pressure.

H. J. Hawthorne. U.S.P. 2,233,260, 25.2.41. Appl. 12.4.38. Means and method of drilling wells by means of a rotary system utilizing hard abrasive particles carried in the mud flush to cut the formations, the abrasive particles being recirculated.

E. G. Leonardon. U.S.P. 2,233,410, 4.3.41. Appl. 4.6.37. Method of and apparatus for exploring drill-holes by means of determination of electrolyte-containing porous beds.

P. Liddicoat. U.S.P. 2,233,421, 4.3.41. Appl. 15.11.37. Detachable drill-bit for percussive drilling.

W. B. Sounitza. U.S.P. 2,233,648, 4.3.41. Appl. 18.12.37. Crown-block construction.

R. B. Bryant. U.S.P. 2,233,692, 4.3.41. Appl. 20.4.39. Drilling apparatus by a rotary system utilizing a flushing liquid for removing the cuttings.

R. D. Heater. U.S.P. 2,233,740, 4.3.41. Appl. 13.1.40. Combination rope-socket and jar, comprising an elongated perforated cylinder and a piston with a head engaging in the cylinder.

C. S. Howe. U.S.P. 2,233,867, 4.3.41. Appl. 18.6.38. Suspension of solids and method of making it for use as an aqueous drilling fluid containing a treater dust.

R. R. Proctor. U.S.P. 2,233,872, 4.3.41. Appl. 27.7.36. Means and method for solidifying underground structures by using an initially fluid but finally set hydraulic cement.

T. H. Dunn. U.S.P. 2,233,973 and 2,233,974, 4.3.41. Appl. 22.6.39 for both. Slow-setting cements containing an alkali metal hexametaphosphate and an alkali-metal triphosphate, respectively.

R. D. Wyckoff. U.S.P. 2,233,992, 4.3.41. Appl. 3.1.38. Method and apparatus for surveying wells by means of measuring the speed of sound in the various formations.

M. Williams. U.S.P. 2,235,955, 25.3.41. Appl. 21.9.37. Addition agent for enhancement of the properties of drilling mud, consisting of a water-soluble glass containing a phosphare radical and a normally solid element.

R. R. Crum. U.S.P. 2,235,982, 25.3.41. Appl. 20.6.39. Core-bit with roller cutters.

G. H. Trevor. U.S.P. 2,236,022, 25.3.41. Appl. 10.7.39. Rope-socket.

A. H. N.

Production.

463.* Removal of Paraffin by Electrical Heating from the Producing Wells in the Texas Panhandle. B. Turner and C. R. Rider. *Oil Gas J.*, 6.3.41, **39** (43), 34. *Paper Presented Before American Petroleum Institute.*—Basically the method supplied heat to melt the paraffin in the tubing by passing a direct current through the tubing and rods and using them as elements of a resistance heater. The tubing is insulated from the tubing-head and casing by special insulators. At a point in the well below which paraffin is known to form, contact is made between the tubing and casing to complete the circuit to the surface. Heat is generated in the tubing and rods rather than in the casing, because the former have a smaller metal area, with a consequent higher resistance.

Current is supplied at the surface by a direct-current, shunt-wound, high-amperage, low-voltage generator. Contact is made to the well-head by means of removable cables, the tubing being used as the positive, and the casing as the negative terminal.

Special well equipment is necessary, and this, together with the details of operations involved, is described and illustrated.

The following conclusions are reached from the study up to date: (1) By electrical heating with a 70-k.w. d.c. generator, the paraffin in the average Texas Panhandle well can be returned to the fluid state in not more than 90 mins. treating time. (2) The cost of installing electrical heating equipment in a well will not, in most cases, exceed one-half that of a normal pulling and stripping job. (3) When a well has frozen tight with paraffin but no mechanical failure has occurred, approximately 80% of the cost of pulling and stripping the paraffin from the tubing and rods can be saved by melting the paraffin electrically and pumping it out of the well. (4) When a well has suffered mechanical failure and substantial amounts of paraffin are between the rods and tubing, approximately 50% of the pulling cost can be saved by melting the paraffin by electrical heating before pulling the well. (5) There are no occupational or well hazards of an unusual nature connected with the application of this process. (6) Fusing of the tubing to the casing or of the contactor to the casing is not possible under the methods of treatment now being used. (7) Fusing of the tubing couplings is not to be feared, because the couplings constitute points of low resistance. (8) In general, in the Texas Panhandle it is not necessary to heat the paraffin in the tubing to a temperature in excess of 100° F. to be able to pump it from the well. (9) The tubing insulators and the contactor offer no obstruction to obtaining the fluid level of the well by the sonic-reflection method. A. H. N.

464.* Practical Economics of Cycling. B. B. Boatright and P. C. Dixon. *Oil Gas J.*, 6.3.41. **39** (43), 41. *Paper Presented before American Petroleum Institute.*—A preliminary investigation is always advisable before seriously considering any cycling project, as this casual survey will frequently reveal conditions that preclude a reasonable chance of success. This survey need not be exhaustive, but should include a brief investigation of available data to determine: (*a*) that the distillate content of the gas is sufficient to justify treatment; (*b*) that there is a possibility of unitizing sufficient acreage to assure an adequate gas reserve; (*c*) that contractual requirements are not prohibitive or, in the event of them being prohibitive, that they can be modified; (*d*) that well potentials are sufficiently high to obviate the necessity for an excessive number of wells; and (*e*) that subsurface conditions are favourable for cycling. In the event of a cycling project appearing desirable after preliminary examination, a thorough evaluation is in order.

Sampling of the well products must be conducted with a maximum degree of accuracy, for all economic considerations will be based on the computed recovery shown from this test. The probable degree of accuracy may bear a relationship to the time of test, or to the degree of refinement of gas and liquid measurement, but in any event the limits of accuracy are known by the person conducting such a test, and these limits should be carried through to the final balance sheet of proposed operations.

Total reserves in place in the reservoir must be calculated, and this is done in the conventional manner. Deviation due to supercompressibility and surface shrinkage due to condensation of liquids should be determined, and the proper correction factors applied if these factors are in excess of the limits of accuracy of the metering or the analyses from which the factors must be calculated. Average sand thickness is derived from the customary sources, but at this point a new element may enter some calculations. If the reserve calculations were being made to determine total gas reserves in place and available for pipe-line sale, the entire sand section containing gas is usually weighed for average porosity and connate water to determine the void space containing gas.

Other factors are similarly studied to decide the drainage and development patterns, plant type and size, the possibility of unitization, etc.

The purpose of this paper is to present in practical form a discussion of factors which, in the ultimate analysis, determine the probable degree of success and profit to be derived from a cycling enterprise. In order to co-ordinate the presentation of many divergent subjects, it is written as though directed to persons who seek a pattern about which they may intelligently attack the problems of inspecting and possibly developing a cycling project. A. H. N.

465.* Energy Requirements for Pumping Oil Wells. S. B. Sargent, Jr. *Oil Gas J.*, 6.3.41, **39** (43), 51. *Paper Presented before American Petroleum Institute.*—The

approach to the problem was started by plotting data from a group of wells in the form of a curve showing production as a function of depth. The wells selected were scattered throughout various areas in the United States.

Some theoretical basis for the performances involved was then sought. It was felt that the solution might lie in the horse-power which any given string of sucker-rods might transmit.

The first step in the study was to develop a method of evaluating the hydraulic horse-power required. The hydraulic horse-power required to produce a well is given by the expression: Hp. = (Brl./day) $\frac{\text{(Operating depth)}}{1{,}000}$ (0·0074). From this, of course, it is necessary to subtract the work done by expanding gas. An approximate expression for the horse-power available by expanding any given volume of gas is: Hp. = $\left(\text{P.V. log}_e \frac{P_2}{P_1}\right)(4{\cdot}75 \times 10^7)^{-1}$.

The utilization of this energy is determined by the efficiency of the system. A graph gives a probability curve for gas-lift efficiency as determined from about 450 installations. The most probable efficiency according to this curve is 10%. This value seems reasonable, and in keeping with the general opinion expressed by various operators.

The determination of the horse-power transmitted by a string of sucker rods is based on the conception of the work involved in deforming them and the number of times/sec. that this is done at a frequency equal to the natural period of the rods. The natural frequency was chosen, as it is a frequency with which the rods vibrate on the imposition of any given force on them.

Equations are developed on these assumptions. This study suggests that sucker-rod pumping has an exceedingly wide application, both as to depth and quantities of fluid which can be produced by the method. It carries the additional suggestion that large quantities of fluid, such as 15,000 bbl./day, are within the realm of sucker-rod pumping. The paper further suggests the possibility of successful pumping of depths of 12,000–15,000 ft.

Perhaps the most pertinent suggestion is that sucker-rod pumping installations are the heavy-duty lifting installations commonly used for pumping oil, and that they are capable of even further development in this field of application. The corollary of this statement is that perhaps in many light installations, heavier pumping installations than necessary are used, which has often resulted in the use of other means of producing oil, whereas the pumping installation might well have served the purpose to better advantage. A. H. N.

466.* Experimental Investigation of Gas-Well Gauging. D. J. Grady, Jr., and A. L. Vitter, Jr. *Oil Gas J.*, 27.3.41, **39** (46), 200.—A preliminary discussion of the accuracy of Oliphant and Reid's formulæ for pitot-tube measurements of gas-flow shows the superiority of the latter formula for open-hole gauging of gas-wells. Pitot-tube measurements can be misleading if stabilization of the well is not certain before the impact-pressure observation is made. Therefore, the time necessary for stabilization must be ascertained to assure reliable open-flow-capacity determinations. Preliminary tests seemed to indicate that in the case of the larger wells, the well is almost stabilized within 15 mins., although a small decline thereafter is realized. On the other hand, actual tests show small wells not having reached stability after 1½ hrs.' blowing.

An attempt was made to establish from fundamental theory what might be the time expected as the time of stabilization. Starting from the equation of state of a gas, Darcy's law of viscous flow of fluids through porous media, and the equation of continuity, the deductions show the time required for stabilization and the predicted open flow at the time under certain assumed conditions. There are, in the theoretical formula, four factors which are unknown, viz., (1) H, effective thickness of producing section; (2) k, permeability of producing section; (3) R_w, well-bore radius; (4) R_e, effective drainage radius.

The assumption of any one of the first three necessarily determines the remaining two, and the fourth is assumed independently. Therefore, only two independent assumptions are made, and both can be estimated within reasonable limits. It is not the intention to accord too much weight to the numerical theoretical deductions, but they do give indications of unreasonably long time-periods for stabilization. Observations support these conclusions.

Back-pressure methods were then tried. The wells were "rocked-up" for 24 hrs. prior to the test, and this practice introduces an abnormal condition around the well. Another difficulty encountered in interpreting the tests was in ascertaining whether the correct shut-in pressure had been obtained. In a majority of the wells the pressure will continue to rise for several days after closing the well in, and the amount that it will rise per day will be irregular and affected by offset operations. Thus it has been established that in the Monroe field the actual blowing of wells to the atmosphere clearly gives unreliable results and involves a pointless waste of gas. The regular back-pressure test is impractical because of the time involved, and shortening of the tests leads to unreliable results. The authors then develop a test which they call "productivity test," and give a chart to simplify its plotting.

The data necessary are the working pressures and respective rates of flow at two different producing rates. The points should be taken such that the working pressures are reduced approximately 10 and 50% from the closed-in pressure. The closed-in pressure may be used as a point in place of the 10% pull-down point, if it is felt that the closed-in pressure is reliable. However, the suggestion is offered that the independence of this test from the closed-in pressure is an advantage, since, as already mentioned, closed-in pressures are more susceptible to error due to offset operations. The simplicity of the productivity well-test form facilitates its use directly in the field or office without the need of calculations, excepting the rate of flow of gas from the orifice-meter readings.

In conclusion, the productivity test is shown to give a reliable gauge in a minimum of time. It is practical for one man to obtain productivity tests concurrently on fifteen to twenty wells over a period of 2–3 days. Thus, it requires about the same amount of time to gauge all the 1300 wells in the Monroe field as is required by pitot-tube open flow—that is, on the assumption that in front of and behind the man making the pitot-tube measurements there are crews breaking down the connections on the wells and making them up again. A. H. N.

467.* Field Tests of Gas show Prospects for Cycling. E. O. Buck. *Oil Wkly*, 3.3.41, **100** (13), 15–17. *Paper Presented before American Petroleum Institute.*—The testing of wet gas and its associated free liquid for liquid content is not a simple process like testing dry gas.

First, the product from the well is two-phase—that is, a mixture of gas and liquid instead of true gas. Second, the amount of liquid or the gas–liquid ratio varies throughout the flow system, depending on pressure and temperature.

A study of the gas–liquid ratio reveals that in most instances all the product is in a gaseous or single-phase state under reservoir pressure and temperature, and that condensation occurs in varying amounts as pressure is released and temperature reduced. Liquid condensation increases until the optimum conditions are reached; the process then reverses and the vaporization of liquid starts. Thus, for any wet gas there is a definite pressure at a fixed temperature where a maximum condensation occurs. This point can only be determined by actual testing.

Field testing has now advanced to a point where, in working in conjunction with the laboratory, all the economics of a recycling plant can be determined. These tests can be taken somewhat as follows: (1) The productivity index of the well or wells should be determined. This test will determine the number of wells necessary to supply a sufficient volume of gas for recycling operations. (2) The total liquid content of the gas must be known. This fact enables the operator to decide if the liquid yield is sufficient, for the volume of gas processed, to offset the expense of constructing and operating a plant. (3) The chemical composition of the flow-stream must be accurately-determined for a basis for plant design. (4) Complete liquid, pressure, and temperature curves must be plotted on the mixture. These data balance the economy of plant-operating pressure with compression costs to give the greatest liquid yield at the lowest possible operating expense.

The potential test can be taken by the usual "back-pressure methods," by producing the well through various size orifices and measuring the gas and corresponding pressure drops. Texas conservation regulations permit a daily production of 25% of the open-flow potential of the well.

The usual physical gas-analysis tests are now conducted by the continuous-sampling method. This method of testing offers many advantages over other methods formerly in use. Some details are included regarding the tests and methods of interpreting the data. A. H N.

468.° New Uses Found for Acid in Production Work. B. Mills. *Oil Wkly*, 10.3.41, **101** (1), 14–17.—Acidization, until quite recently a practice confined to increasing oil and gas production from limestone formations, is now being employed extensively for many other purposes, including dissolving or removing drilling mud left in or on the producing formation; cleaning screens and perforations; releasing stuck drill-pipe; cleaning and completing salt-water-disposal wells; completing gas-injection wells, and increasing oil and gas production from sand formations.

Development of an acid or chemical solution capable of dissolving the mud cake often left in producing wells prompted use of acid for treating the sand formation itself. The acid acts as a solvent for bentonitic materials and carbonates, and apparently increases the porosity and permeability of the oil-sand near the hole.

One acid developed for dissolving clays used in drilling mud consists of such agents as inhibited hydrochloric acid, to which have been added several chemicals that sharply change the action of the solution. The additions include several wetting agents and surface-tension reducing agents. The acid used for treating the oil-sand to increase porosity and permeability is the same as or similar to that used for dissolving mud and for cleaning screens and perforations. Laboratory tests have proved that the solubility of clays is increased greatly in hydrochloric acid by the addition of certain agents. Chemical companies making this acid have, however, withheld its exact nature.

Inhibition of the chemical solution is a prime consideration, since high bottom-hole temperatures tend to accelerate the corrosive action of certain acids. Screen design also is such that only inhibited acid may be used with safety.

Various acidizing jobs varying widely in character and objective to be attained are given in some detail.

Several unusual results have been observed after acid treatment in sand wells. In one well making 15 brls. of water and 20 brls. of oil daily before treatment, water production after treatment was reduced to zero and oil production increased to 37 brls. In another well that made no water along with 41 brls. of oil daily before treatment, water production after treatment was 77 brls. and oil production 25 brls. daily.

Acid has been used to free stuck drill-pipe, but results have not been altogether favourable. Where it has been possible to concentrate the acid on the affected area, the drill-pipe has been freed in a few wells. It is often difficult to determine the exact point of trouble in the hole, and the failure of many attempts to free drill-pipe has not been the fault of the acid. A. H. N.

469. Patents on Production. J. B. Stone and P. G. Shelley. U.S.P. 2,232,931, 25.2.41. Appl. 23.3.38. Method of treating wells with hydrochloric acid in which a small proportion of certain classes of organic aromatic nitrogen compounds is added.

L. C. Chamberlain. U.S.P. 2,232,938, 25.2.41. Appl. 1.2.39. Treatment of wells with hydrochloric acid solution containing between 5% and 20% of a water-soluble calcium salt.

D. G. Hefley. U.S.P. 2,232,946, 25.2.41. Appl. 2.3.38. Method of cleaning wells by means of alkaline starch solution to remove detritus by means of gas pressure, and later decomposing the solution deposits on the tubing by means of hydrochloric acid.

G. A. Humason and W. J. Clay. U.S.P. 2,233,013, 25.2.41. Appl. 25.1.38. Combination packer and swab device.

K. T. Penick. U.S.P. 2,233,029, 25.2.41. Appl. 14.6.38. Counterbalance device for use with the walking-beam of a well-pumping unit, consisting of a pneumatic cushioning device.

K. T. Penick. U.S.P. 2,233,030, 25.2.41. Appl. 15.7.38. Pump-plunger.

C. P. Gillespie and E. L. Barber. U.S.P. 2,233,077, 25.2.41. Appl. 10.10.38. Well-controlling apparatus, to be used with flowing wells, in which a valve located in one of the branches of the Christmas tree closes when rate of flow exceeds a certain predetermined value.

H. W. Ramey. U.S.P. 2,233,225, 2,233,226, and 2,233,227, 25.2.41. Appl. 14.9.37, 8.8.38, and 27.12.38, respectively. Hydropneumatic counterbalance for parts having uniform relative movement, utilizing gases and liquid in compression chambers.

R. G. De La Mater. U.S.P. 2,233,245, 25.2.41. Appl. 3.8.37. Hydropneumatic counterbalance for a member having uniform relative movement, utilizing gases, and liquids in compression chamber.

J. G. Staudt. U.S.P. 2,233,271, 25.2.41. Appl. 17.2.38. Treatment of wells by means of alternate introduction into the formation of acid alone and of acid and a non-penetrating liquid mixture to seal the pores of the formations.

M. De Groote and B. Keiser. U.S.P. 2,233,381 and 2,233,382, 25.2.41. Appl. 6.3.40 for both. Flooding processes for recovering oil from subterranean oil-bearing strata in which an aqueous solution of a water-soluble, surface-active, alkaline earth-resistant polyglycol ether of certain reactions is used.

F. M. Mason. U.S.P. 2,233,672, 4.3.41. Appl. 6.12.37. Submersible electrical motor having a neutral liquid in the casing of the motor, and a gas-forming apparatus for lowering the liquid in the casing and creating a gaseous atmosphere.

V. A. Hoover. U.S.P. 2,233,890, 4.3.41. Appl. 8.12.37. Eccentric suspension and cable connection for submersible motor-pumps.

F. A. Witt. U.S.P. 2,233,930, 4.3.41. Appl. 4.8.38. Oil-well cleaner for perforated casing by means of blasting portions of a sleeve, which is supported against the casing, through the perforations.

W. F. Grisham. U.S.P. 2,236,137, 25.3.41. Appl. 25.2.38. Flow-valve for use in well-tubing.

G. D. Johnson. U.S.P. 2,236,177, 25.3.41. Appl. 21.12.36. Control-valve for well-casings.

G. N. Foggan. U.S.P. 2,236,210, 25.3.41. Appl. 2.11.39. Oil-well pump and sand-trap.

C. A. Combs. U.S.P. 2,236,332, 25.3.41. Appl. 7.7.39. Well-control equipment consisting of a separator for water and oil-fluids. A. H. N.

Natural Gas.

470.* Liquefying Natural Gas for Peak Load Supply. R. W. Miller and J. A. Clark. *Chem. Met. Eng.*, January 1941, **48** (1), 74–76. *Paper Presented before American Gas Association.*—Generally speaking, the pipe-line has been the gas-holder of the natural gas utility. Natural gas has been stored in the pipe-line by the simple expedient of raising pressures therein during the night to the limits allowable. The gas thus stored is available during the following day.

It has become increasingly evident, however, that such a method is not entirely successful under all conditions, and must be supplemented or augmented by storage at or near the point of use. Various methods were tried between August 1937 and 1939.

By September 1939 research work had progressed sufficiently far in the laboratory to warrant the erection of a pilot plant, wherein relatively large quantities of natural gas could be liquefied, stored, and regasified, making use in a practical way of the methods developed on a small scale, and whereby certain preconceived ideas could be tried out for the first time.

It was realized that early in cooling the gas for liquefaction, water, and carbon dioxide would solidify and completely plug the tubes, so that these materials had to be removed at the very start of the process. For this, a scrubbing plant using mono-ethanolamine and diethylene glycol was first introduced, followed by two tanks filled with granulated aluminium oxide to remove the last trace of water vapour.

For storages a horizontal symmetrical tank was used, 10 ft. in diameter by 18 ft. long, holding 14,500 gal., equivalent to about 1,000,000 cu. ft. of gas. This was made of alloy-steel plates, and was covered with 2 ft. of formed cork, cemented on and water-proofed with bituminous tar.

The working of this pilot plant and the conclusions reached are reported in detail. Based on these conclusions a large-scale plant is being built using spherical tanks with 3 ft. of cork insulation for storing the liquid. A. H. N.

471. Natural Gas in Brantford Area, Ontario. J. F. Caley. *Canada Department of Mines and Resources. Geol. Surv. Paper* 40–22. Ottawa, 1940.—The author of this report, which is the forerunner of a more detailed and comprehensive paper on the same subject, suggests that, in view of the present more or less acute natural gas position, possibilities of increased production both from tested and untested parts of Brantford Area, Ontario, might usefully be investigated.

The area includes approximately 4800 sq. miles, and extends in an east–west direction from Dundas to Aylmer and in a north–south direction from Mount Forest to the north shore of Lake Erie. At the present time production is confined to that part of the area which lies south of the latitude of Paris. All the natural gas is drawn from rocks of Silurian age—namely, Clinton, Guelph, Grimsby, and Whirlpool formations.

Contours drawn on top of the Clinton formation show that the general structure on this horizon has a southerly dip averaging about 24 ft. per mile over the entire producing area. There are local variations and reversals in dip, but few definite folds with strutural closure. There is no apparent relation between structure and the presence or absence of producing gas. Accumulations of gas are for the most part due to the porous character of certain beds and the existence of gentle anticlinal rolls or decreases in regional dip.

Inasmuch as presence or absence of features favouring accumulation of natural gas cannot be foretold and there is no evidence of their being confined to the southern productive area, it is conceivable that they may equally occur in other parts of the area. In fact, if, as the author believes, porosity, differential cementation, and stratigraphic form, combined with gentle anticlinal rolls and local flattenings of the regional structure, account for the gas-fields so far discovered in Brantford Area, then much of the untested country in the southern part intervening between producing areas should prove worth testing.

Natural gas has so far not been found in commercial quantity in that part of the area north of the latitude of Paris and, of the producing horizons in the south, only the Guelph presents any prospects of production in the northern region. Nevertheless only a relatively small amount of drilling has been done, and the fact that shows of gas have been obtained might justify further exploration. H. B. M.

472.* Dehydrogenation of Propane Gas Produced from Kinsui. K. Shiomi and H. Nishimata. *J. Soc. Chem. Ind. Japan*, December 1940, **43** (12), 451 B.—An investigation has been made of the hydrogenation of propane gas from Kinsui at the reaction temperature from 500° to 700° C. with Al_2O_3–Cr_2O_3 as catalyst. The yield of total olefines in the presence of catalyst was much larger than that obtained in its absence at the same reaction temperature. The units are shown in the following table :

Reaction temperature (° C.).	Flow rate (l./hr.).	Degree of expansion *	Concentration of olefines in exit gas, % by vol.				Conversion to olefines, % by vol.			
			C_4H_8.	C_3H_6.	C_2H_4.	Total.	C_4H_8.	C_3H_6.	C_2H_4.	Total.
518	4·8	1·30	4·30	9·20	3·07	16·57	5·82	12·5	4·15	22·47
606	,,	1·80	5·62	11·4	5·08	22·10	10·20	20·4	9·15	39·75
650	,,	1·82	3·95	14·1	10·1	28·15	7·20	25·7	18·4	51·30
703	,,	2·02	2·90	10·8	17·9	31·60	5·83	21·8	36·2	63·83

B. M. H. T.

473.* Composition of Natural Gas Produced from Kinsui, Taiwan. A. Matui and M. Yasuda. *J. Soc. Chem. Ind., Japan.* December 1940, **43** (12), 454B.—The composition of the natural gas was determined using Podbielniak's low-temperature fractionating apparatus.

The result of the analysis is as follows :

0·74% CO_2; 94·75% CH_4; 2·30% C_2H_6; 0·86% C_3H_8; 0·27% O_2; and 1·08% N_2.

B. H. M. T.

* The ratio of the volumes found after and before the reaction.

Cracking.

474.* Hydro-Cracking of Gas Oil, Part I. H. Otuka and Y. Miyahara. *J. Soc. Chem. Ind.*, Japan, November 1940, **43** (11), 363B.—The effect of reaction temperature has been observed on the hydro-cracking of a Siragiku gas-oil, ammonium thiomolybdate being used as catalyst. The yield of liquid products was highest at 400° C. and lowest at 550° C., the maximum yield being at 450° C. The hydro-cracked gasoline consisted mainly of naphthene, paraffin, and aromatic hydrocarbons.

At temperatures between 400° C. and 500° C. the hydrogen consumption was almost constant (3–4% by weight of the sample).

At 550° C. the apparent consumption of hydrogen was very small owing to hydrogen evolution, due to dehydrogenation reactions which occurred at this temperature.

B. M. H. T.

475.* Hydrocracking of Gas Oil, Part II. H. Otuka and Y. Miyahara. *J. Soc. Chem. Ind., Japan*, December 1940, **43** (12), 454B.—This investigation deals with the hydro-cracking of a Siragiku gas-oil in the presence of nickel catalyst. The maximum yield of hydro-cracked gasoline was (as in the case when molybdenum catalyst was employed —see Abstract No. 474) obtained at the reaction temperature of 450° C. The amount of gaseous products including heavy hydrocarbon gases adsorbed by active charcoal increased rapidly with the rise of reaction temperature. Comparing the results with those obtained with the molybdenum catalyst, it is seen that the amount of gaseous products was generally larger with the nickel catalyst, except at 400° C.

The nickel catalyst was more destructive in action and more sensitive to temperature than the molybdenum catalyst. B. H. M. T.

476. System of Interlocking Air-Operated Controllers Applied to Oil Cracking. S. H. Isaacs. *Instruments*, 1940, **13** (8), 216.—A system of controllers is described which enables the top temperature of a distillation tower and the temperature and oil level in an accumulator drum to be automatically maintained by a single stream of oil.

P. D.

Hydrogenation.

477. Patents on Hydrogenation. A. V. Grosse. U.S.P. 2,231,446, 11.2.41. Appl. 14.4.37. Catalytic hydrogenation of hydrocarbons by subjecting them at a temperature between 400° and 700° C. to contact with dehydrogenating catalysts. The reaction is carried out in containers the inner surfaces of which, exposed to the hydrocarbons and catalyst, are composed of an alloy consisting essentially of aluminium and copper, and are substantially free from iron and tin.

H. Dreyfus. U.S.P. 2,231,990, 18.2.41. Appl. 20.7.38. Production of hydrocarbons by the reaction of carbon monoxide and hydrogen in the presence of a hydrogenating catalyst. The absolute pressure in the reaction zone is normally above 0·5 atmosphere, but is periodically reduced to below 0·5 atmosphere without interruption of the flow of the reactant gases whenever the activity of the catalyst falls considerably. H. B. M.

Polymerization.

478.* Catalytic Polymerization of Ethylene under Ordinary Pressure. Y. Konaka. *J. Soc. Chem. Ind., Japan*, November 1940, **43** (11), 363B.—Continuing the researches on the polymerization of CH_4, the author has studied the effect of H_2 and N_2 as media on the formation of polymer oil. When CH_4 and H_2 mixture was used, lower yields of polymer oil were obtained than with CH_4 alone, the proportion distinctly decreasing with increasing amount of H_2. Nitrogen had no effect on the polymerization of CH_4 apart from acting as a diluent. The rôle of CH_2 in the course of oil formation was also investigated. Using CH_2 alone, the oil yield was very poor and catalytic activity was quickly destroyed. CH_2–H_2 mixture in proportion 1 : 1 gave the maximum yield of polymer oil and the longest catalytic life. The polymer oil obtained from the latter was mainly composed of aromatic and olefinic hydrocarbons, and the greater part of the product distilled above 100° C. These results were quite different from

those obtained with the oil from CH_4 only, which was composed of paraffinic hydrocarbons and distilled below 100° C. The chemical composition of the oil obtained from CH_2, CH_4, and H_2 mixture also distinctly differed from that of the oil from CH_4 only, the former being mostly composed of aromatic and olefinic hydrocarbons.

B. M. H. T.

479. Patents on Polymerization and Alkylation. Standard Oil Development Co. E.P. 534,151, 28.2.41. Appl. 22.8.39. The invention refers to the conversion of normal or straight-chain hydrocarbons into more valuable isomers having branched-chain structure, and particularly to the conversion of straight-chain paraffinic hydrocarbons into branched-chain olefins. The original hydrocarbons are subjected at a temperature between 600° and 1100° F. at atmospheric pressure for a period of 5–200 sec. to the actions of isomerization catalysts. Examples of such catalysts are aluminium oxide and aluminium silicate in porous form such as bauxite, clay, kaolin, alone or on a carrier such as silica gel. They may be further activated by treatment with a mineral acid or a Friedel–Crafts catalyst such as aluminium chloride or iron chloride.

V. Komarewsky. U.S.P. 2,230,461, 4.2.41. Appl. 25.2.38. Production of aromatic hydrocarbons by contacting normally gaseous olefins at polymerizing temperature with a granular catalyst comprising a phosphoric acid and a metal of the eighth group of the periodic table.

A. Schwarcman. U.S.P. 2,230,470, 4.2.41. Appl. 8.2.39. Polymerization or bodying of fatty oils by heating to a temperature between 500° and 600° F. in the presence of a small amount of a polycyclic aromatic compound carrying at least two phenol groups and a carboxyl group, and adapted to catalyze polymerization of the oil.

E. T. Layng. U.S.P. 2,230,648, 4.2.41. Appl. 1.6.39. Method of converting olefinic hydrocarbons into hydrocarbons of higher-boiling points by contacting the former at an elevated temperature with catalytic material comprising as an essential ingredient mercury pyrophosphate.

E. T. Layng. U.S.P. 2,230,978, 4.2.41. Appl. 1.6.39. Treatment of an olefin-rich hydrocarbon mixture by contacting it at an elevated temperature with catalytic material containing as an essential ingredient a metal pyrophosphate capable of reduction to an active modification which is a polymerization catalyst. The catalytic material is maintained in a reducing atmosphere other than the said olefin-rich hydrocarbon mixture at an elevated temperature, and for sufficient time to effect reduction of a portion of the metal pyrophosphate to the active modification thereof. Thereafter passage of the olefin-rich hydrocarbon over the catalyst is initiated at a temperature not much greater than 600° F.

J. C. Morrell. U.S.P. 2,231,452, 11.2.41. Appl. 16.10.39. Production of higher-molecular-weight hydrocarbons from paraffin and olefin hydrocarbons by simultaneously contacting an alkylatable paraffin and an olefin with a phosphoric acid catalyst at a controlled reaction temperature.

M. Levine. U.S.P. 2,233,951, 4.3.41. Appl. 8.4.37. Method of polymerizing gaseous olefinic hydrocarbons to produce low-boiling liquid hydrocarbons. The hydrocarbons are heated in their reaction zone in contact with nitrosyl chloride and at a temperature sufficiently high to effect polymerization of the hydrocarbons. Afterwards they are condensed and the liquid hydrocarbons so formed collected.

H. B. M.

Refining and Refinery Plant.

480.* Testing of Furnace Oils Presents Difficult Problem. A. W. Trusty. *Refiner*, March 1941, **20** (3), 71–73.—Generally clean, distilled oils are necessary for satisfactory operation of pressure burners. A viscosity of 45 sec. is considered the maximum for good operation on pressure-type burners operating at low feed-rates.

Pot-type and vaporizing burners have no fans or blowers, and generally burn a No. 1 grade of oil. Domestic atomizing-type burners of the gun-and-vertical-rotary type generally burn a No. 3 oil. The significance of flash point, pour point, water and

sediment, carbon residue, ash, distillation, sulphur, colour, thermal value, and of stability tests is briefly described in short paragraphs for each test. Three tests for stability are given: the ferric sulphate test, the heater test, and the oven test.

The deposition of sludge during the heating test is apparently caused by condensation of some of the more unstable unsaturated hydrocarbons. However, it should be noted that the unsaturates are not the sole cause of the sludge. In some cases it is reported that straight-run oils have caused complaints of sludge deposition. Part of the deposit in this case was no doubt caused by the formation of soaps by reaction of the copper or iron equipment with organic acids in the oil. Resinous condensation products may also be formed.

The source of most furnace oils is usually: (1) straight-run oil from the topping operation; (2) gas oil from the cracking operation. In the past most of the furnace oils were straight-run products. Cracked furnace oils could be produced which would meet all the specifications for a No. 1, 2, or 3 oil, but complaints of poor colour stability and sludge formation were received in some cases.

Colour stability is a requisite for a satisfactory oil, not from a performance viewpoint, but from the customer sales viewpoint.

Another more serious complaint was the deposition of a sludge, or resin, which clogged filters, lines, and burner tips. The factors which accelerated this condition were: (1) Brass or copper lines and screens. The copper metal acted as a catalyst to accelerate the deposition. (2) Heat. Some types of burners were equipped with pumps which by-passed the excess oil back into the storage tanks. This excess oil received a certain amount of preheating, which gradually raises the temperature of the main body of oil in the storage tank. (3) The type of oil. In general, the more highly cracked oils, containing high percentage of unsaturated compounds, have more trouble with sludge deposition.

A strong caustic wash has been found effective in treating cracked furnace oils. Usually a caustic wash is not sufficient treatment to produce a satisfactory oil as tested by any of the three suggested methods, but in most cases the caustic wash will reduce the sludge-depositing tendency to half its original value.

Treatment with sulphuric acid and subsequent neutralization with an alkali is probably the surest and most effective method of producing a satisfactory oil. The quantity of acid will vary with the nature of the oil, but 3–10 lb. of acid/brl. will be sufficient for most types of cracked gas-oil. A. H. N.

481.* Centrifugal Separation of Doctor-Black-Strap Emulsions. H. Bottomley. *Refiner*, March 1941, **20** (3), 74–76.—In all doctor-treating systems black-strap emulsions—*i.e.*, PbS–spent Plumbite–oil—are present to some extent, depending on the type of material being treated and the local conditions affecting such treatment. It is the general condition that more black-strap emulsion is formed in doctor-treating sour gasolines than those of lesser mercaptan content. Also the type of treating equipment, batch or continuous, affects the emulsion formation in addition to other factors, such as the turbulence obtaining in the mixture of the reagents with the oil, the hardness of the water used in making up the doctor solution, and soaps present in the oil being treated.

The continual formation of these emulsions, which are difficult to break economically by former means, substantiates many of the arguments against doctor treatment. The loss of the oil contained in the emulsion, the chemical inactivity of the lead sulphide that is coated with the oil, and the utilities required properly to regenerate the recovered black-strap are items that loom large in the treating schedule. If the oil phase is not completely removed from the treating solution, heavy ends remain, that on subsequent revivification of the lead sulphide are oxidized, thus causing deterioration and increase in the gum content of stocks treated with this solution. In addition to the monetary loss involved in evaporating the gasoline from the black-strap, the vapours evolved constitute a distinct fire-hazard.

Gravity settling of these emulsions is not successful, as judged after many years of experience. The purpose of the centrifuge described is to accelerate the settling rate and make the separation sharper than is normally obtainable by multiplying the force of gravity by a large number. Until recently no centrifuge was available that could discharge solid material continuously; the machine described successfully accomplishes this separation. The centrifuge is described in detail, but to understand its operation

reference should be made to the original paper for the illustrations. It is a modified bowl-type; the solid material is discharged continuously from the bowl without the use of any moving mechanical contrivance. A. H. N.

482.* Perco Copper Sweetening. M. W. Conn. *Refiner*, March 1941, **20** (3), 77–85.—Discussing the chemistry of copper-sweetening, it is noted that the reaction is essentially an oxidation–reduction one, involving the mercaptan constituents of the sour oil and cupric copper solutions. This fact imposes on the design and operation of a copper-sweetening unit two fundamental conditions, viz. (*a*) that the sour oil be intimately contacted with the copper solution, and (*b*) that the cuprous chloride and hydrochloric acid formed in the reaction be retained in the solution and intimately contacted with molecular oxygen as the revivifying agent. As a result of these two requirements, two separate and distinct modes of application of copper-sweetening have been developed which are generally known as the "solid process" and the "liquid and solution process," both of which are based on identical chemical principles.

It is essential in either process to have the sour oil free of hydrogen sulphide and elementary sulphur prior to contact with the copper reagent. Unless these substances are removed by stabilization and refractionation, caustic washing is usually employed in the conventional manner for the removal of hydrogen sulphide, or a caustic solution of polysulphide ions may be employed for the removal of both elementary or corrosive sulphur and hydrogen sulphide. Some gasolines have an inherent tendency to retain caustic solution in suspension for periods longer than it is economical to allow for proper settling. In these cases it is expedient to add some sort of filter between the caustic settler and the copper treater—usually sand and rock, to knock out the final traces of suspended caustic.

A detailed account is given in the succeeding paragraphs of both the solid and the solution processes.

The materials of construction for the pre-caustic wash and the sodium sulphide systems are ordinary steel, as required in any conventional caustic washing system. It is customary to apply one or two coats of an acid-resisting varnish to the interior walls of the steel reagent towers used in solid units. The application of this varnish prevents any corrosion of the interior of the tower by the solid-copper reagent.

In a solution-process unit that portion of the equipment which is in contact with copper solution, including the copper contactor, separating tank, regeneration tanks, and the intermediate piping, valves, and fittings, must be made of a corrosion-resistant material capable of withstanding the copper solution. Due to a series of important improvements that have been made in the last few years in suitable corrosion-resistant materials, the design of the recently constructed solution-process units differ to a very large extent from that of the first commercial unit put into operation several years ago. These differences are detailed.

Curves for construction costs are given for both processes. After discussing operation advantages, several typical plants are discussed to illustrate certain of these advantages. In conclusion it is stated that the copper-sweetening processes described unquestionably prevail in economy and quality of product and simplicity of operation over doctor-treating. As motor-fuel specifications improve, and particularly as anti-knock requirements increase, monetary savings from these processes will be correspondingly increased. Copper-sweetening is more versatile in its application to various types of gasoline stocks, and therefore does not require the technical control and readjustment necessary in doctor-sweetening units. Copper-treating units, with respect to cost and return on investment, compare favourably with other types of refinery equipment, being substantially equal in quality and serviceability.

A. H. N.

483.* Solutizer Sweetening and Gasoline Stability. D. L. Yabroff, E. L. Walters, A. C. Nixon, and H. B. Minor. *Refiner*, March 1941, **20** (3), 87–89.—The treating agent employed in the solutizer process is a strong caustic solution to which has been added a suitable organic material, termed a "solutizer," and this results in a caustic solution of "high solvency power" for mercaptans. Previous publications have discussed the underlying theory of the process, the extraction and regeneration steps, the attractive improvement in octane number and lead susceptibility as compared to the untreated sour gasoline, pilot-plant studies, and finally the operation of a 15,000-brl./day commercial plant at the Wood River refinery of Shell Oil Co., Incorporated.

The present article, on the solutizer process, discusses the general aspects of gasoline stability, and the effect of solutizer sweetening in particular. In evaluating the influence of any treating process on stability, it is important to separate the effect of the particular process itself and the effect of natural inhibitors that may be present. A method for doing this is presented, based on the " basic inhibitor susceptibility " of the gasoline.

Solutizer-sweetening preserves the inhibitor susceptibility, whereas many other sweetening methods cause a degradation in this property due to the introduction of deleterious by-products.

Gasoline sweetened with a " mixed "-type solutizer solution (contains both *iso*-butyrate and alkyl phenolate salts) will have a definite alkyl phenol content, because of the equilibrium established with the alkyl phenol salts in the solutizer solution itself. In many cases this equilibrium alkyl phenol concentration in treated gasoline is more than sufficient to assure adequate stability.

Two new commercial solutizer plants, just beginning operation in California, will utilize a " mixed "-type solutizer solution to sweeten full-range cracked gasoline.

A. H. N.

484.* The Study of Water Problems in Atmospheric Cooling Systems. D. W. Haering, D. M. Considine. *Refiner*, March 1941, **20** (3), 91–96.—Problems occurring in these systems are influenced by atmospheric contamination from gases, such as oxygen, carbon dioxide, and hydrogen sulphide, bacteria, algae, and dust, which frequently introduces appreciable amounts of silica into the equipment. Velocity, temperature, and incomplete wetting of metal surfaces are design features, and a variety of metals and alloys present in systems encourage and introduce water problems inherent to the systems, unless corrective treatments are employed.

Corrosion occurs commonly in atmospheric cooling systems because of the repeated aeration of the water. The problem is not solved conveniently by oxygen removal, because of this fact. The high velocities obtaining in condensers and in connecting rods of internal-combustion engines accelerate the corrosion rate. The rate of corrosion is still further increased by the multiplicity of voltaic couples normally present in large cooling systems.

Living organisms are a serious problem in cooling systems, and algae, bacteria, or both may be factors responsible for scale, corrosion, or simply slime found on heat-transfer surfaces. Apart from repeated contamination due to atmospheric contact, the property of many of these organisms of developing resistance to unfavourable environments, including chemcials intended to destroy them, is a difficult and disconcerting factor in their control.

The present paper is a preliminary to a series of pure research studies which will isolate the individual ions and elements and determine the critical limits responsible for scale and corrosion troubles in this type of system. In addition, the relative effectiveness of various chemicals in the control of these factors, plus the control of bacterial and algal factors, will be studied.

From experimental facts presented in the paper in detail the following conclusions are reached: (1) It is possible to duplicate plant-operating conditions in the laboratory and obtain identical scale and corrosion results obtained in practice. (2) Dissolved solids concentrations are an important factor in scale control, and determine to a large extent the effectiveness of chemicals employed for treatment. (3) Sulphate and silica deposits are factors in cooling-system operation. (4) Phosphate chemicals hydrolyze, reducing, if not eliminating, the effectiveness of so-called threshold treatment. (5) This type of research is important in isolating factors and concentrations effecting scale and corrosion control in this type of system. A. H. N.

485.* Total Removal of Sulphur Compounds is Goal of Sweetening Technique. P. M. Robinson. *Nat. Petrol. News*, 21.8.40. **32** (34), R. 298.—Used originally only for the purpose of improving the odour of gasoline, sweetening processes assumed a greater significance when anti-knock properties became important. All existing processes based on the conversion of sulphur compounds possess some disadvantage of greater or less importance. The development of the " solutizer " processes which remove all sulphur bodies from the gasoline are a big step forward. It is suggested that the only really satisfactory solution is the removal of sulphur bodies from the crude. H. G.

486.* High-Temperature Creep Strength Checked for Low-Alloy Steels. R. F. Miller, W. G. Benz, and W. E. Unverzagt. *Nat. Petrol. News*, 21.8.40, **32** (34), R. 306.—The creep strengths of seventeen low-alloy steels of different compositions and after different heat treatments were determined at 1000° F. The C.S. of C/Mo steels increases with increasing Mo content, both in the normalized and normalized and tempered conditions. In the latter condition the C.S. is lower than in the former. In the normalized (only) condition the steel is less stable than after tempering. An increase in the Mn and C content of normalized and tempered C/0·5% Mo steel produces a slight increase in the C.S. An addition of Cr, Si, or Al to these steels tends to impair C.S., and Ti and Cb to improve it. Conservative estimates of C.S. should be based only on materials possessing a stable structure. H. G.

487.* Thermal Insulation for Industry. S. V. Saginor. *Chem. Met. Eng.*, January 1941, **48** (1), 82–86.—The historical development of insulating material from the first commercial clay and asbestos-fibre type from a century ago up to the present time is given.

A good insulant is generally constructed on the basic principle of numerous air-cells which prevent the flow of heat. Highly polished light-coloured metals, however, such as aluminium foil, although inherently not insulants, serve to retard the flow of heat by functioning as reflectors. Since the original efficiency of commercial insulants depends primarily on the voids they contain, these voids should preferably be microscopically small, so that circulation within them and radiation across them will be reduced to a minimum.

Further, the material must be adaptable to the condition for which it is being considered—that is, the insulant must be of such form as to be easily applied. It must have high original resistance to heat-flow and the ability to retain this resistance; it must have sufficient strength for proper handling and application. Ability to withstand wear and tear encountered in service is also important. In some cases it should be vermin-proof, not susceptible to bacterial growth and, in itself, odourless. It must have the ability to withstand the temperatures to which it will be subject without appreciable deterioration. To be effective at low (refrigeration) temperatures, the insulant should be, in itself, highly resistant to moisture-vapour penetration, or be properly protected by an asphalt coating, asphalt-impregnated membrane, or other suitable vapour barrier.

A detailed list of basic data, a knowledge of which the author finds essential in making an analysis of the proper type and thickness of insulation for industrial requirement, is given. The properties of insulants are discussed. A. H. N.

488.* Slurry-Type Copper Treater Stops Octane Number Losses. R. G. Atkinson. *Nat. Petrol. News*, 11.12.40, **32** (50), R. 450.—In the plant described yellow pressure distillate is scrubbed with caustic soda to remove H_2S, saturated with water and passed with controlled quantities of oxygen through a slurry of clay and cupric chloride. After settling, the distillate is washed with water and sodium sulphide to remove copper salts. The process is claimed to eliminate vapour and emulsion losses and to cause no significant drop in the octane number. In cost the process is claimed to be comparable with the usual "doctor" treatment. H. G.

489.* Alkylation Plant in California. C. K. Viland and J. Seth. *Oil Gas J.*, 12.9.40, **39** (18), 32.—A sulphuric-acid alkylation plant was completed in June 1940 at a refinery in Avon, California, producing from *iso*butane and butylenes a light 92–93 O.N. blending stock and a heavy alkylate of slightly lower O.N. The *iso*butane-bearing charging stock is derived from cracking-plant operations, straight-run gasoline stabilization, and from natural gasoline plants. The butylene charge-stock is derived from two debutanizer units handling depropanized pressure distillate. The average charge consists of 73% cracked butanes and 27% straight-run butanes, one-quarter of the former being charged to the reactor unit and three-quarters to the alkylation de*iso*butanizer column (to recover maximum *iso*butane and dispose of surplus butylenes). *iso*Butane–butylene ratio is kept at between 5 : 1 and 8 : 1, acid being continuously added to keep the strength of the acid in the system at over 90%. Propane refrigeration removed the heat of reaction, keeping the temperature to 40–50° F. The mixed reaction products are neutralized and debutanized, the *iso*butane being returned to the de*iso*butanizer column. Fractionation of the stabilized product yields three

alkylate grades, a light grade of O.N. 92·5 and boiling range 135–310° F., an intermediate grade of O.N. 83·0 and boiling range 314–390° F., and a residue of O.N. 80·0 and boiling range 396–644° F. The first product is suitable for blending into high-octane aviation spirit. Operation of the plant has been smooth and efficient since its installation, only two men per shift being required for control. C. L. G.

490.* Application of Catalytic Desulphurization Process. M. W. Conn. *Oil Gas J.*, 24.10.40, **39** (24), 40–47.—The lead susceptibility of gasolines is directly influenced by sulphur content, and hence increased attention has been given recently to removal of this sulphur. It is now realized that the conception that gasoline is sufficiently refined if doctor sweet and non-corrosive does not go far enough, and further processes, such as cold acid treatment and the use of mercaptan-solvent-inducing agents in the caustic washing systems, have been introduced. In the opinion of the author, these processes are inefficient and uneconomic, and he would replace them by catalytic decomposition of the organic sulphides to H_2S—the Perco catalytic desulphurization process.

In this process the raw gasoline is passed over the catalyst at 750° F. and 1½–2 atmospheres, cooled, and the H_2S removed by a caustic wash. Mercaptans, alkyl and aromatic sulphides, and disulphides are readily converted into H_2S and the corresponding hydrocarbons, thiophanes and carbon disulphide with more difficulty, and thiophenes least readily of all. Fortunately these last have the least unfavourable results on lead susceptibility. Reduction of sulphur content is therefore dependent on the original thiophene content, and is generally upward of 85% for uncracked and about 50% for cracked and polymer gasolines.

Tables of the properties of eight different gasolines before and after pilot-plant desulphurization are given, together with those of three gasolines treated on a commercial plant. Straight-run gasolines show, on desulphurization, an increase in octane number of about 2 units for the base spirit itself, whilst with base spirit + 2 c.c. TEL/gal. the corresponding increase is about 8 units. Cracked and polymer spirits show an increase of about 2–3 units for the base spirit, and about 4 units for base spirit + 2 c.c. TEL/gal.

In the case of one of the commercial plants in operation processing 1000 barrels per day, the total operating cost per day is $56·04, exclusive of indirect charges. Since the tetraethyl lead saving is approximately 18 cents per barrel, the economic advantages of the process are apparent. T. T. D.

491.* The Combustion Gas Turbine. J. T. Rettaliata. *Engineer*, 1940, **170** (4411 and 4412), 63–65 and 78–79.—A gas turbine unit is described, which consists of a five-stage reaction turbine direct coupled to a fifteen-stage axial compressor. Part of the air discharged from the compressor is used for combustion of oil and the remainder mixes with the products of combustion, cooling them to a satisfactory temperature for expansion in the turbine. A description of the mechanical construction of the unit is given.

The turbine operates on the Brayton cycle which is composed of two isentropic and two constant pressure lines. This cycle is examined in terms of temperature–entropy and temperature–enthalpy diagrams.

Axial compressors have the advantage of a higher efficiency than the centrifugal type, but suffer from the disadvantage of a limited range of stable operation. Although a reaction turbine bears a physical resemblance to an axial compressor, the design problems associated with each are quite different. For instance, in the turbine reheating caused by friction leads to an overall efficiency better than the stage efficiency, but in the compressor the reverse is the case.

The effects of turbine inlet temperature, compressor pressure ratio, and turbine and compressor efficiencies on overall thermal efficiency are given; and, in this connection, it is mentioned that the highest operating temperature of turbine units built to date is 1000° F. Factors leading to the selection of the axial type of compressor for use in conjunction with the turbine are discussed.

Altitude and temperature have a large effect on the available power output and diagrams are given showing the extent of the variations. The author points out that loss of power may be made up by water injection, although this is uneconomical.

Various applications are mentioned, such as: the use in oil refineries, where the compressed air can be used in a process and the necessary heat obtained from the

process itself; for supercharging Velox boilers where the exhaust gas from the boiler drives the turbine; and the possibility of adaptation to railway locomotives. A 2200-h.p. gas turbine locomotive now being built is described. J. G. W.

492.* Creep under Combined Tension and Torsion. Part I.—The Behaviour of a 0·17% Carbon Steel at 445° C. H. J. Tapsell and A. E. Johnson. *Engineering*, 1940, **150** (3887, 3889, 2891, 3892, and 3894), 24–25, 61–63, 104–105, 134, and 164–166.—The apparatus used by the authors in their experimental work is described. The test specimens were tubular in form, the material for which had been heat-treated before machining; finishing was by lapping and polishing. The measurement of axial and circumferential creep simultaneously and independently was obtained by means of optical systems enabling small changes to be observed.

Tests were of about 150 hours duration, readings being taken at frequent intervals during the first day and thereafter at daily intervals. Experiments were made with pure tension, pure torsion, and several ratios of torsion to tension stress.

Curves of axial and circumferential creep stress were found in all cases to have the same geometrical form, and each individual curve was therefore derived from the common curve. No axial creep took place in the pure torsion tests, which, in the authors' opinion offers strong evidence that the creep in a plane is unaffected by the stress acting normally to it. Except in the case of pure torsion, creep occurred in the direction of the tube-wall thickness, indicating that shear stresses on planes in addition to those of maximum shear take part in producing creep.

Various theories are examined in relation to the results obtained, from which the authors concluded that the plain difference of maximum shear stresses was not a satisfactory stress function, and they give suggested expressions for the principal creep rates in which the principal stresses were proportional to the difference of the nth power of the maximum shear stresses. There was no evidence that a strain-energy function was essential to the theory.

Appendices are given, showing the method of computing from the measured creep rates the corresponding rates in the three directions of principal stress for the thin-walled tubular specimen subjected to combined stress; and a theoretical analysis of the various theories that have been suggested. J. G. W.

493.* Catalytic Cracker Specializes in 100 Octane Fuel Base. M. G. Van Voorhis. *Nat. Petrol. News*, 30.10.40, **32** (44), R. 386.—High octane number catalytic-cracked gasoline has hitherto been excluded from military aviation by virtue of its high acid test, a measure of the unsaturateds content. Although this is not considered to be a valid reason for the exclusion owing to the nature of the unsaturateds in this type of gasoline, the replacement of the existing catalyst by a new synthetic one shortly to be available is stated to obviate this disadvantage. A 10,000 bbl. unit is described in some detail. H. G.

494.* Make High-Grade Neutrals by Cracking Bright Stock. C. R. Wagner. *Nat. Petrol. News*, 25.12.40. **32** (52), R. 460.—The tendency towards the increasing use of lower viscosity lubricants for automobile engines is increasing the demand for "neutral" oil at the expense of bright stock. In the process described bright stock is blended with 10% of kerosine and heated in shell stills, in the presence of steam. The distillate to 525–550° F. is naphtha and gas oil. The rates of heating and steam supply are then controlled to maintain the viscosity of the overhead stream at 90–120 S.U.S. at 100° F. The final still temperature is 700–720° F. The yield is claimed to be 98% and the cost 3·25 cents per gallon. H. G.

495.* Sharpness of Separation in Batch Fractionation. A. Rose, L. M. Welshans, and H. H. Long. *Industr. Engng Chem.*, 1940, **32** (5), 668, 673, and 675.—In the first of these papers a method is developed for calculating the sharpness of separation when hold-up is negligible, the size of the intermediate fraction (defined as having composition between 10 and 90% of the more volatile component) being used as criterion. Only reflux ratios approaching infinity are considered.

In the second paper the method is extended to include cases where hold-up is appreciable, the reflux ratio being infinite.

Finally, in the third paper, a general equation is derived which allows the calculation

to be made for all reflux ratios and values of hold-up. The equation is solved graphically. P. D.

496. An Unusual Temperature Controller Job. V. H. Heirmeier. *Instruments*, 1940, 13 (8), 217.—A distillation unit comprising a prefractionator and main column is described which, due to the pressure and level interconnections between the prefractionator and main receiving tanks suffers from surging. This can be suppressed by suitable temperature control applied to the top of the main fractionator. P. D.

497. Patents on Refining and Refinery Plant. Edeleanu Gesellschaft m.b.H. E.P. 533,348, 11.2.41. Appl. 31.10.39. Process for cooling oils preparatory to extraction by the Edeleanu process, on the countercurrent principle. The fresh oil is admixed with extract solution, if desired after precooling the oil in a heat exchanger, and sulphur dioxide caused to evaporate from the mixture by suction. Thus the heat required for evaporating the sulphur dioxide is derived directly from the mixture.

Standard Oil Development Co. E.P. 534,111, 27.2.41. Appl. 27.12.39. Improved process for the recovery of phenols from petroleum oils. A phenol-containing petroleum oil is contacted with an alkali, the oil separated from the resultant sludge containing alkali phenolates and the said alkali sludge extracted with a solvent for the oil. Thereafter the solvent extracted sludge is blown with steam or an inert gas and the phenols regenerated by acidification. As a rule solvents employed are from the class of lower boiling petroleum hydrocarbons, *e.g.* solvent naphtha and gasoline.

A. W. Nash. E.P. 534,212, 3.3.41. Appl. 22.7.39. Method of reducing the wax content of a wax-containing oil by extraction with a solvent only partially miscible with the wax-free oil present in the wax-oil mixture treated. The solvent is further only partially miscible or immiscible with the wax present in the wax-oil mixture at an operating temperature equal to or above the melting point of the wax, but below the critical solution temperature of the wax with the solvent. The solvent may be either an aliphatic saturated ketone, an aliphatic monohydric alcohol, a fatty acid, a monohydric phenol, a phenylamine, a nitro-derivative of benzene, or an alkyl-benzene, a halogen ester of the glycols, furfural, or furfuryl alcohol.

F. J. Soday. U.S.P. 2,230,274, 4.2.41. Appl. 26.5.38. Method of purification of the resin-forming unsaturated hydrocarbon content of a light oil fraction. The fraction is contacted in the liquid phase with a reagent comprising sulphuric acid, 50% in concentration, but free from appreciable amounts of sulphur dioxide and sulphur trioxide, and containing a compound capable of furnishing an ion containing manganese in quantity equivalent to at least 0·1% by weight of potassium permanganate.

C. J. Wilson. U.S.P. 2,231,147, 11.2.41. Appl. 30.7.38. Separation of a mineral oil boiling in the range 100–700° F. into relatively more paraffinic fractions and relatively more aromatic fractions. The oil is contacted with a solvent selected from the class consisting of methyl acetoacetate and its halogen substitution products under conditions to form a solvent extract phase and a paraffinic phase. Thereafter the respective phases are separated and the solvent is removed.

R. E. Burk. U.S.P. 2,232,435, 18.2.41. Appl. 31.8.38. Production of lubricating and solvent oils from cracked residual petroleum by the distillation from the petroleum of fractions corresponding generally to gas oil range and to lubricating range. A desired fraction thereof is then subjected to the action of a small amount of maleic anhydride at a temperature of 200°–225° F. for a few hours. The resultant material is washed with a caustic alkali solution, then with water, and blown with air. The resultant material is finally subjected to the action of a small amount of boronfluoride at 60°–250° F. for several hours, washed with water and blown with air at 200°–250° F.

R. E. Burk and E. C. Hughes. U.S.P. 2,232,436, 18.2.41. Appl. 31.8.38. Method of purifying light petroleum distillates by removing hydrogen sulphide in such a way that substantial amounts of oxygen-containing acid reacting carbon ring compounds and mercaptans are not also withdrawn. Thereafter the oxygen-containing acid-reacting carbon ring compounds in the distillate are selectively converted to metal-

containing compounds and removed by subjection to the action of a dilute caustic soda solution of 0·5–8° Baumé. Finally the mercaptans are acted on by a more concentrated caustic soda solution.

G. L. Parkhurst. U.S.P. 2,232,722, 25.2.41. Appl. 25.2.32. Method of dewaxing and fractionation of a wax-bearing oil into fractions relatively paraffinic and naphthenic with respect to the original oil. The oil is mixed with a selective solvent adapted to assist the precipitation of wax at low temperatures; the mixture chilled to cause precipitation of substantial wax; the wax removed; and the remainder of the mixture chilled to a lower temperature to cause the mixture to separate into two liquid phases. Finally the liquid phases are separated and the solvent recovered.

E. H. Records and J. E. Louttit. U.S.P. 2,232,971, 25.2.41. Appl. 6.6.39. Method of desulphurizing hydrocarbon oil by mixing with a quantity of oil a treating mixture comprising ferric chloride, alum, alcohol and benzol, and then heating the mixed oil and treating mixture under pressure. H. B. M.

Synthetic Products.

498. Patent on Synthetic Products. Standard Oil Development Co. E.P. 533,327, 11.2.41. Appl. 27.10.39. The invention relates to improved detergents and wetting agents, the latter implying substances which improve spreading of surface coatings and increase spreading and penetration powers of liquids such as aqueous solutions of oils. The process comprises condensing with phosphoric acid or a pentavalent phosphoric acid derivative which hydrolyzes to phosphoric acid, phenolic compounds substituted in the aromatic nucleus with saturated alkyl or *cyclo*-alkyl groups and neutralizing the resulting acid ester with an alkali metal base to produce an ester salt. H. B. M.

Fire Prevention.

499.* Properties of Flammable Liquids and Gases. The Associated Factory Mutual Fire Insurance Companies. *Industr. Engng Chem.*, 1940, **32**, 880.—The flash point, explosive limits, auto-ignition temperature and susceptibility to spontaneous heating are given for several hundred organic compounds and natural products. Suitable extinguishing agents for dealing with fires arising from the combustion of these substances are recommended. J. W. H.

Chemistry and Physics.

500.* Elements of Vaporization and Condensation. Part XII. R. L. Huntington. *Refiner*, March 1941, **20** (3), 97–102.—The paper deals mainly with the application of the Kremser Method to the design of oil absorbers. The two principal factors to be considered in the design of the bubble plate tower are: (1) provision of ample flow capacity for the oil and gas streams so as to prevent liquid hold up and entrainment; (2) a fairly close approach toward equilibrium between the gas and oil on each bubble plate.

To take care of factor No. 1 calls for: (*a*) adequate down-spouts wherein the entrained vapour can free itself from the oil froth which is formed as the oil flows across the bubble caps; (*b*) liquid seals at the base of the down-spout to prevent the flow of gas upward through the down-spout; (*c*) a tray spacing of 20 ins. or more, generally 24 ins., between successive plates, in order to reduce entrainment or the mechanical carrying of liquid droplets upward from plate to plate.

Factor No. 2 requires the following considerations: (*a*) placement of bubble caps in staggered rows so as to reduce the tendency for the oil to channel across the plate; (*b*) proper height for the overflow weir in order to give the rising gas stream a sufficiently deep body of oil to penetrate on each plate; (*c*) ample velocity through the slots to provide intimate contact between the gas and oil; however, the velocity must not be so high as to cause the friction loss in feet of fluid to approach the equivalent head of oil and froth in the down-spout.

Typical worked-out examples on an oil absorber and stripper design illustrate the use of the Kremser chart as modified by Souders and Brown. This chart is based on an algebraic derivation in which a material balance is made around n equilibrium plates. A number of simplifying assumptions are made among which are: (1) the volume of residue gas is substantially the same as the raw gas value; (2) the ratio of L/V or mols. of lean to mols. of lean gas is a constant for the absorber as well as the ratio of V/L mols. of steam to mols. of lean oil for the stripper; (3) the liquid volumes are additive.

After studying the effects of varying the pressure and other factors, the choice of an absorption oil is studied. The oil should have an initial boiling point well above the end point of the raw natural gasoline, so that the oil will not distil over with the gasoline. The oil should be free of heavy ends which may cause too high a pour test, thereby resulting in solidification of the oil in the cooling coils. Waxy hydrocarbons should be absent (or present in very small amounts). Heavy asphaltic fractions may promote the formation of emulsions which are highly undesirable. The number of mols./unit of liquid volume should be a maximum. This result can be usually accomplished by selecting a low molecular weight oil. The absorption oil should be one from which the gasoline constituents can be readily denuded or stripped out in the still. In high pressure absorbers operating at 600 lbs. or more, higher molecular weight oils are recommended since there is a tendency for vaporization to take place in the retrograde region, especially for the lighter oils. A. H. N.

501. Computation of some Physical Properties of Oils at High Pressures. I. Density. R. B. Dow and C. E. Fink. *J. App. Phys.*, 1940, **11**, 5, 353.—The density of a fluid lubricant at pressure p lb. per sq. in. gauge is given by an equation of the form

$$\rho = \rho_0(1 + ap - bp^2)_t$$

ρ is the density at pressure p and temperature t, ρ_0 the corresponding density at atmospheric pressure. The constants a and b are evaluated over a temperature range 20 to 220° F., and the equation holds up to pressures of 50,000 lb./sq. in.

The equation was derived for mineral oils, but holds also for fish, animal, and vegetable oils. P. D.

502.* Viscosity of Gases and Vapours at High Pressures. E. W. Comings and R. S. Egly. *Industr. Engng Chem.*, 1940, **32**, 714.—It is shown that from a knowledge of the viscosity at atmospheric pressure, the critical pressure, and the critical temperature it is possible to calculate the viscosity of gases and vapours at high pressures to an accuracy of 20%, this error being comparable with the difference between the values found for the same pure vapour by different investigators. The relationship between the variables is expressed in the form of a graph relating the reduced pressure and reduced temperature to the ratio of the viscosity at atmospheric pressure to the viscosity at the desired pressure. The graph is constructed from the experimental determinations of the viscosities of gases and vapours at high pressures made by a large number of different observers. The basis of the method is the concept of corresponding states which follows logically from the kinetic theory of gases, from which the compressibility factor has been shown to be approximately equal for a wide variety of compounds at equal reduced temperatures and pressures. The compressibility factor is derived from the ratio of the kinetic pressure to the ideal pressure. This ratio may be replaced by the ratio of the viscosity at the desired pressure to the viscosity at a pressure sufficiently low to be independent of pressure (*i.e.* atmospheric pressure). From theoretical considerations it is also shown that the thermal conductivity and diffusivity at high pressures may be calculated by replacing the viscosity ratio by conductivity or diffusivity ratios. No data are, however, available for checking the validity of this application of the corresponding state concept. J. W. H.

503.* Phase Equilibria in Hydrocarbon Systems. B. H. Sage, H. M. Lavender, and W. N. Lacey. *Industr. Engng Chem.*, 1940, **32**, 743.—The volumetric behaviour of mixtures of methane and decane over the temperature range 70° to 250° F. and at pressures up to 4500 lb./sq in. has been determined. This range of temperature and pressure covers measurements in the condensed liquid and two phase regions. From this data the partial specific volumes of methane in decane and decane in methane have been calculated. J. W. H.

504.* Destructive Hydrogenation of High Molecular Weight Polymers. V. N. Ipatieff and R. E. Schaad. *Industr. Engng Chem.*, 1940, **32**, 762.—Destructive hydrogenation of *iso*butene polymers, butadiene polymer and rubber has been carried out in the presence of black nickel oxide. The apparatus employed consisted of an electrically heated rotating autoclave, made of stainless steel, the reaction temperature was 250° C. and the initial hydrogen pressure was 100 kg. per sq. cm. at 25° C.

The *iso*butene polymer was obtained by polymerising *iso*butene in liquid propane solution in the presence of aluminium chloride and hydrogen chloride, and was a white rubber-like compound. On destructive hydrogenation under the above operating conditions, and removal of the solvent, fractions were obtained consisting of octanes, dodecanes, hexadecanes and hydrocarbons of the formula $C_{44}H_{90}$. The products from the destructive hydrogenation of *iso*butene polymer are thus essentially paraffinic.

Butadiene polymer was produced by heating this hydrocarbon at 150° C. under 40 atmospheres pressure. Destructive hydrogenation of this polymer produced only naphthenic hydrocarbons.

Similarly naphthenic hydrocarbons were formed when a natural rubber was subjected to destructive hydrogenation.

Hydrogenation of *iso*prene yielded *iso*pentane in addition to cyclic hydropolymers.

H. E. T.

505.* Thermodynamic Properties of Paraffins and Olefins. R. H. Ewell. *Industr. Engng Chem.*, 1940, **32**, 778.—This paper presents a critical correlative study of the data available on the entropy and heat of formation, particularly at 25° C. of the paraffin and olefin hydrocarbons. Extrapolation of the experimental data on the lower members of these two series of hydrocarbons yielded a set of rules for estimating the entropies and heats of formation of any paraffin or olefin at 25° C. These properties are tabulated for all paraffins through the octanes and for all olefins through the hexenes.

The data obtained can be used to calculate the approximate state of equilibrium in any hydrocarbon reaction. For example, the equilibrium proportions of 2 : 3-dimethyl-1-butene, 3 : 3-dimethyl-1-butene, and 2 : 3-dimethyl-2-butene at 300° C. are calculated to be 25·4 : 2·2 : 72·4 in comparison with Whitmore's experimental values of 31 : 3 : 61. Equilibrium calculations for the paraffins show that in the temperature range 150° to 175° C. all the isomeric hydrocarbons in any group of isomers have approximately the same free energy. The more highly branched isomers are more stable below this temperature range and the straight-chain ones more stable above it.

H. E. T.

506.* Retrograde Condensation. D. L. Katz and F. Kurata. *Industr. Engng Chem.*, 1940, **32**, 817.—A general description of the phenomenon of retrograde condensation; including a discussion of the physical state of the material in this region.

P. D.

507.* Correlating Vapor Pressure and Latent Heat Data. D. F. Othmer. *Industr. Engng Chem.*, 1940, **32**, 841.—Vapour pressures of liquids, solids, solutions having a non-volatile component, solutions having two or more volatile constituents, hydrates losing water by efflorescence, and of other materials undergoing decomposition, give straight-line relations when plotted on logarithmic paper against values of the vapour pressures at corresponding temperatures of a reference substance. The gradient of the line is equal to the ratio of the latent heat or other local heat quantity involved in the evolution of the vapour to the latent heat of the reference material. These results indicate the validity of the equation

$$\log P = L/L' \log P' + C$$

where P, P' are pressures, L, L' molal latent heats of the two compounds at the same temperature, and C is a constant.

Graphs have been constructed to illustrate the utility of this relation with various materials in checking and correlating vapour pressure data.

Latent heats have been evaluated and checked; and heats of fusion, of hydration, of dissociation, of dilution or solution, and of chemical reactions are shown to be elated to the graphical method and may be calculated.

Freezing points, enthalpy charts, steam distillation relations, and many related phenomena may also be conveniently studied by this method.

A comprehensive relation is developed which includes all of the other general methods used for graphic vapour pressure representation. In addition other useful forms of equation for similar calculations are suggested. H. E. T.

508. Sensitive Method of Flow Control. M. G. Martin. *Instruments*, 1940, **13**, 8, 214.—The head on the upstream side of a V notch weir (chosen in preference to an orifice for ease of cleaning) is used to control the rate of flow of a liquid by means of an automatic valve. In order to obtain the necessary control accuracy the valve actuating mechanism must respond to changes in head of 0·025 inches. This is too small a change for a float, and the difficulty is overcome by using a submerged pipe upstream from the weir, with a small discharge of air into the liquid, the pressure in the pipe actuating the controller. P. D.

509. Flow of a Gas through Porous Media. J. L. Fowler and K. L. Hertel. *J. App. Phys.*, 1940, **11**, 7, 496.—Kozeny's approximate solution to the problem of fluid flow through porous media is developed, and the resulting formula checked by experiments on air flow through plugs of cotton, wool, rayon, and glass wool. P. D.

510.* Mechanism of Catalytic Hydrogenation of Phenol Under High Pressure. S. Ando. *J. Soc. Chem. Ind., Japan*, November, 1940, **43** (11), 355 B.—*cyclo*Hexanol and *cyclo*hexane, assumed to be the intermediate products to form methyl*cyclo*pentane from phenol, were hydrogenated in a continuous apparatus, molybdenum sulphide being employed as catalyst.

The sample and hydrogen were continuously charged at a constant speed into the reaction chamber, which was maintained as high as the required reaction temperature and pressure. The products were discharged continuously from the chamber, the pressure being kept constant. The hydrogen was fed at such a rate that the residual gas was drawn off at the required rate.

In one experiment 144 c.c./hr., of *cyclo*hexanol were charged into the reaction chamber, 155 lit./hr. residual gas were drawn off. The reaction temperature was 380° C. and reaction pressure 200 atm. In the other experiment, 145 c.c./hr. of *cyclo*hexane were charged, 149 lit./hr. residual gas drawn off, the reaction temperature being 379° C. The composition of the products obtained was compared. The following observations were made: (1) a greater part of *cyclo*hexanol was converted into hydrocarbons boiling at about 70–80° C. (2) In each experiment, the main fraction of the oil obtained may be taken as being composed principally of *cyclo*hexane and methyl*cyclo*pentane. (3) The proportion of methyl*cyclo*pentane contained in the main fraction of the saturated hydrocarbons obtained is remarkably larger in the case of *cyclo*hexanol than with *cyclo*hexane. The reaction to produce methyl*cyclo*pentane from *cyclo*hexanol is thus not simply:

*cyclo*hexanol → *cyclo*hexane → methyl*cyclo*pentane

but proceeds through another intermediate. In the present experiment, *cyclo*hexane and methyl*cyclo*pentane were actually produced from *cyclo*hexanol, and the content of the latter hydrocarbon was remarkably larger than the amount which is expected to be formed by the isomerisation of *cyclo*hexane.

Strong support is thus offered to the assumption that *cyclo*hexanol is the intermediate product. B. M. H. T.

Analysis and Testing.

511.* Investigation of High-Boiling Petroleum Oils by Adsorption Analysis. B. C. Allibone. *J. Inst. Petrol.*, March 1941, **27** (209), 94–108.—This paper describes the application of "chromatographic adsorption" to the analytical separation of the high-boiling components of petroleum. B. H. M. T.

512.* Ollett Tube Cleaner. E. A. Evans. *J. Inst. Petrol.*, March 1941, **27** (209), 118.—An apparatus for burning off the carbon residue from Ramsbotton coke bulbs is described and illustrated. B. M. H. T.

Motor Fuels.

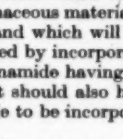
513. Recent Developments in Motor Spirit Production. M. E. Kelly. *Fuel*, 1940, **19** (5), 107.—This article contains a short review of recent trends in the production of motor fuels. H. E. T.

514. Notes on Recent Developments in Fuel Technology. J. Hiles and J. K. Thompson. *Fuel*, 1940, **19** (5), 105.—A short review of recent developments in fuel technology covering such topics as electrical thawing of frozen water pipes, octane ratings, the private motorist and alternative motor fuels, the separation of gaseous and liquid mixtures. H. E. T.

515. Patents on Motor Fuels. D. B. Macdonald. E.P. 533,978, 25.2.41. Appl. 30.10.39. The object of the invention is to provide a material which when added to liquid fuels for use in internal combustion engines reduces pinking and knocking tendencies. The improvement involves the addition to such a fuel of a composition consisting of naphthalene and one or more nitriles either with or without one or more other improvers for liquid fuels such as wool wax, chlorophyll, and distilled bone.

E. I. Du Pont de Nemours. E.P. 534,147, 28.2.41. Appl. 18.8.39. Process for the production of improved motor fuels which will have a reduced tendency to form adherent deposits of gums or carbonaceous materials on the various parts of the engine with which they come in contact and which will soften, loosen, or remove any such deposits. These objects are achieved by incorporating in the fuel a minor proportion of an *N*-substituted organic sulphonamide having a melting point below 75° C. and a boiling point of at least 300° C. It should also have a high solvent power for kauri gum. The amount of sulphonamide to be incorporated varies over a wide range, but is ordinarily between 0·01 and 5%.

P. Miller and A. Y. Mottlau. U.S.P. 2,230,844, 4.2.41. Appl. 25.11.38. Preparation of an improved high octane number motor fuel consisting of a gasoline base fuel having a clear octane number above 75, 0·5 to 10 c.c. of tetra ethyl lead per gallon of fuel and from 1–5% of a compound of the formula



in which R represents a hydrocarbon radicle selected from the class consisting of *iso*-alkyl and alkyl-phenyl radicles, and R_1 represents hydrogen and alkyl substituents in the benzene nucleus attached to N.

A. Breitling. U.S.P. 2,231,525, 11.2.41. Appl. 8.7.38. Preparation of hydrocarbon fuels of a boiling point higher than that of commercial gasoline for use in atomized condition. The fuel is supplied to a line leading to the atomizer, heated in direct contact with copper and the temperature maintained at a point which renders the fuel appreciably hot but not above the boiling point of water.

F. E. Frey, P. V. McKinney, and W. H. Wood. U.S.P. 2,233,363, 25.2.41. Appl. 27.6.36. Continuous process for reacting paraffins of low molecular weight with normally gaseous olefins to produce predominantly paraffinic oils in the motor fuel range and of higher molecular weight. H. B. M.

Gas, Diesel and Fuel Oils.

516. Patents on Gas, Diesel, and Fuel Oil. Standard Oil Development Co. E.P. 533,427, 13.2.41. Appl. 4.7.39. Process for the production of mixtures of hydrocarbons composed substantially of saturated normally liquid hydrocarbons boiling within the gasoline range. A mixture containing at least one *iso*paraffin boiling below the desired gasoline range and with at least one *mono*-olefin having not more than five carbon atoms or a low molecular weight polymer or copolymer, is reacted at a temperature above 10° F. in the presence of at least one metal halide and at least one alkyl halide.

Standard Oil Development Co. E.P. 533,645, 18.2.41. Appl. 17.8.39. On the basis that certain esters of thiophosphoric acid when added to a Diesel fuel improve not only lubricating properties but equally ignition properties, a new fuel has been devised. This comprises a hydrocarbon fuel and a small amount of a compound having the general formula RS_xPX where R is an alkyl, *cyclo*alkyl, aralkyl or alkaryl group, and X represents oxygen or sulphur.

J. G. Fife. E.P. 534,236, 3.3.41. Appl. 7.9.39. Process for the catalytic cyclization of paraffinic or olefinic hydrocarbons with more than 5 and at most 12 carbon atoms in the molecule. For example the invention is applicable to the manufacture of toluene from *n*-heptane or *n*-heptene, the treatment of paraffinic or olefinic gasolines with a view to obtaining gasolines with higher octane numbers, etc. The hydrocarbons are contacted at a temperature between 400° and 600° C. with a catalyst containing aluminium oxide and chromium oxide in the molecular ratios (10–40): (90–60) and also alkali compounds in such a quantity that at most 15–20 of alkali metal atoms are present per 100 molecules of aluminium oxide–chromium oxide mixture.

H. G. M. Fisher and S. H. Hulse. U.S.P. 2,230,642, 4.2.41. Appl. 13.8.38. Preparation of a liquid fuel oil composition having improved combustion characteristics. The mixture consists of a heavy fuel oil substantially free of suspended solid particles, having a gravity in the range 1° to 15° A.P.I. and containing 0·1–3% of an addition agent selected from the class of oil-soluble naphthenates of the group consisting of iron, cobalt, and manganese naphthenates.

B. H. Shoemaker. U.S.P. 2,230,817, 4.2.41. Appl. 21.12.36. Method of improving ignition properties of a Diesel fuel by treating a Diesel fuel distillate with a mixture of sodium plumbite solution and sulphur in the presence of an added mercaptan. The sulphur is used in quantities ranging from 50–350% in excess of the theoretical amount required to sweeten the distillate.

C. M. Loane and B. H. Shoemaker. U.S.P. 2,234,005, 4.3.41. Appl. 11.10.37. Production of a non-ring-sticking Diesel engine lubricating oil consisting of a mineral lubricating oil and 0·5–5% of an organic aluminium sulphonate derived from the petroleum sulphonic acid resulting from the treatment of mineral oils with concentrated sulphuric acid. H. B. M.

Lubricants and Lubrication.

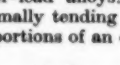
517.* The Wear–Load Characteristic of the Four-Ball Test with Various Lubricants. R. Schnurmann. *Engineering*, 1940, **149**, 567.—The conditions for wear to take place during sliding are surface oxidation, thinning out of the boundary film to make it assume adhesive properties or the existence of an electric field. There is no evidence that welding of the rubbing surfaces takes place at the moment of seizure. The joint action of the above factors cannot result in anything but very irregular time–friction charts. The lower the dielectric breakdown strength the better the quality of a gear lubricant with respect to wear. The wear–load characteristic can be regarded as a guide for the selection of suitable lubricants for various mating materials and conditions of load and speed. J. W. H.

518. Studies in Lubrication. Part VIII.—Lubrication of Plane Sliders. F. Morgan, M. Muskat, and D. W. Reed. *J. appl. Phys.*, 1940, **11** (8), 541.—Experimental determinations were made of lubrication in the thick-film region for both fixed angle and pivoted slides. Viscosity, relative speed of sliding, and load were varied. Three stationary surfaces, steel, brass, and bronze, were used. The moving surface was of steel. Deviations between experiment and theory for the fixed sliders were explained on the basis of inaccuracies in the sliders. The pivoted slides gave excellent agreement with theory. P. D.

519. Patents on Lubricants and Lubrication. L. A. Mikeska and J. F. Nelson. U.S.P. 2,230,543, 4.2.41. Appl. 30.12.38. Preparation of a lubricant having a high tempera-

ture stability. The lubricant consists of a hydrocarbon of low volatility and from 0·1% to 2% by weight of a phosphite ester.

A. W. Lewis. U.S.P. 2,230,691, 4.2.41. Appl. 11.3.37. Lubrication of bearing surfaces having substantially the corrosion susceptibility characteristics of cadmium–silver, cadmium–nickel and copper–lead alloys. A lubricant comprising mineral hydrocarbon oil of a character normally tending to corrode such alloys, but having incorporated therein inhibiting proportions of an oil soluble compound of the general formula



is applied to the bearing surfaces. R may be an alkyl, aryl, or aralkyl residue and R' may be hydrogen or an alkyl, aryl, or aralkyl residue.

J. H. Bartlett. U.S.P. 2,231,148, 11.2.41. Appl. 14.10.38. Preparation of a composition of matter consisting of a mineral lubricating oil and a condensation product obtained by condensing at least 5 parts by weight of an aliphatic acid halide and 1 part by weight of a petroleum lubricating oil in the presence of an active halide condensing catalyst, hydrolyzing and removing residual catalyst. The reaction products are afterwards distilled to remove low boiling constituents and to obtain the desired distillation residue.

A. R. Workman. U.S.P. 2,232,421, 18.2.41. Appl. 21.9.39. Manufacture of a lubricant consisting of a hydrocarbon oil and a relatively small amount of a plastic material including a homogeneous body composed of plasticizing proportions of an organic phosphine and an organic elastic compound selected from the group consisting of rubber, halogenated rubber, synthesized rubber compounds, etc.

L. Auer. U.S.P. 2,232,649, 18.2.41. Appl. 21.4.30. Preparation of a lubricant consisting of a major proportion of a mineral oil and a small amount of an aryl sulphonyl chloride.

J. G. McNab. U.S.P. 2,233,426, 4.3.41. Appl. 14.10.38. Production of an improved crankcase lubricant consisting of a mineral lubricating oil and small amounts of polyvalent metal soaps selected from at least two of the groups of aluminium, nickel, and the alkaline earth soaps. The total amount of soaps present is from $\frac{1}{10}$–3% of the oil, and the amount of soap from any one of the three groups is at least 10% of the total amount of soap present.

W. L. Steiner. U.S.P. 2,233,436, 4.3.41. Appl. 22.1.40. Preparation of a composition comprising in combination a major proportion of a lubricant and a minor proportion of a physical solution of elemental sulphur in uncombined form dissolved in a minor proportion of a solvent, comprising a halogen-bearing alkylated aromatic compound.

W. A. Smith. U.S.P. 2,233,683, 4.3.41. Appl. 9.8.35. Method of insuring uniform and maximum effectiveness of lubricant in the manufacture of lubricants in which a halogenated hydrocarbon film strength increasing agent and an oxygen-bearing friction reducing agent are added. The lubricant and at least one of the agents are heated under conditions of temperature and pressure and for a period of time which will eliminate free moisture, and the mixture homogenized while hot.

J. W. Teter and F. M. Watkins. U.S.P. 2,234,096, 4.3.41. Appl. 28.1.39. Preparation of an improved lubricating oil containing 2–6% of a diphylamine having at least 10 carbon atoms in at least one of the alphyl group. H. B. M.

Asphalt and Bitumen.

520. Patent on Asphalt and Bitumen. Standard Oil Development Co. E.P. 533,927, 24.2.41. Appl. 31.8.39. The adhesivity of asphalts to mineral aggregates in paving compositions is improved by incorporating in the asphalt a small proportion of a salt

of a polyvalent metal containing in the molecule at least one organic radicle derived from an organic acid having a molecular weight of not more than 120, and at least one organic acid radicle derived from an organic acid having a molecular weight greater than 120. The low molecular weight acid may be, for example, acetic acid, propionic acid or butyric acid. The salt may be derived from a high molecular weight fatty acid, naphthenic acid, acid obtained from the oxidation of paraffin wax, or sulphonic acid from the refining treatment of petroleum oil with strong sulphuric acid.

H. B. M.

Special Products.

521.* Economic Aspects of Synthetic Glycerine Production. E. C. Williams and Associates. *Chem. Met. Eng.*, January 1941, **48** (1), 87–89. *Paper Presented before American Institute of Chemical Engineers.*—The economics of glycerine is discussed for the period 1920–1940. The average selling price for C.P. glycerine over the years 1920–1940 as quoted in the trade press is about 16c./lb. During this period there have been three peaks; at 28c. in 1920, at 32c. during 1926 and 1927, and at 29c. during 1937. The lowest trough was reached, following a gradual decline through the post 1929 depression years, at a price of 10c. during 1933. Studies are made also of production and consumption records.

A short report is given of glycerine intermediates. Epichlorohydrin is undoubtedly the most interesting of the intermediates so far as the synthesis of glycerine derivatives is concerned. Fortunately this chlorine-containing epoxide is readily isolated and actually more easily obtained than glycerine itself. The reactivity of epichlorohydrin lies in its epoxide ring, and generally speaking any compound with an active hydrogen atom can be made to open the ring in the following manner:

$$RH + H_2C(O)CH - CH_2Cl \longrightarrow RH_2C - CH(OH) - CH_2Cl.$$

The resulting chlorohydrin can then be reacted further, so that an unlimited number of glycerine derivatives becomes readily available.

A. H. N.

522.* Rubberlike Properties of Polybutene. W. J. Sparks, J. E Lightbrown, L. B. Turner, P. R. Frolich, and C. A. Klebsattel. *Industr. Engng Chem.*, 1940, **32**, 731.—Butene polymers produced at low temperatures possess physical properties similar to rubber. They differ from rubber chemically in that they are essentially saturated.

The commercially available polybutenes (Vistanex) have not been vulcanized by conventional methods involving the addition of sulphur and accelerators. Rubber cracks very rapidly in the presence of ozone at low concentrations, but polybutenes are inert; rubber mixtures containing in excess of 50% polybutene are also inert to ozone. Polybutenes are inert to acids and their inertness is also exhibited by mixtures of more than 50% polybutene with rubber. Spheres of polybutene do not bounce at room temperature, but at 212° F. the rebound is similar to that of rubber.

The electrical properties of polybutene closely resemble rubber. Since rubber and polybutene are physically similar, but are essentially chemically different in regard to saturation, it is possible to draw the conclusion that the vulcanization, ozonization, and oxidation of rubber are due to unsaturation, and that the general physical similarity is independent of orientation due to carbon–double bond–carbon configuration.

J. W. H.

523.* Carbon Black in Rubber Compounding. D. Parkinson. *Trans. I.R.I.*, August 1940, **16** (2), 87. *Discussion*, February 1941, **16** (5), 283.—The particle size of carbon blacks can be approximately determined by a centrifugal method.

Blacks well dispersed in rubber solutions behave similarly in centrifugal fields to blacks dispersed in water and the particle size is the same in both media.

Intensity of blackness is closely related to particle size in the case of all blacks produced from natural gas, the darker the black the smaller its particles. Thus, the nigrometer, which measures blackness, provides a rapid method of comparing particle sizes.

B. M. H. T.

524.* Mineral Oils as Mosquito Larvicides. H. D. Lord. *J. Inst. Petrol.*, March 1941, 27 (209), 73–93.—Murray's recent investigations have shown the importance of the

spreading pressure of an oil in malarial control. Toxicity is not so crucial as has been previously accepted.

The spreading power of an oil can be characterized by the determination of its surface pressure in the Langmuir–Adam apparatus, a description of which is given. The effects on Malariol of storage, exposure to diffused and bright sunlight, and addition of resin are described. The essential requisites of a superior anti-malarial oil are discussed, and it is shown that a residue from pressure distillate fulfils these requirements. B. H. M. T.

525. Patents on Special Products. The Enfield Cable Works, Ltd. E.P. 533,444, 13.2.41. Appl. 11.8.39. Alteration in composition of the viscous liquid normally used for impregnating the laminated di-electric material of electric cables. The impregnating compound according to this invention consists of a solution or suspension of normally solid polymers of ethylene in a mineral oil.

J. G. Fife. E.P. 533,933, 24.2.41. Appl. 13.10.39. It is claimed that the interior of engine cylinders remains clean, that the deposition of carbonaceous products on pistons and in piston ring grooves can be opposed, and that piston rings can be prevented from sticking, if soaps of Tallöl and polyvalent metals are added to the lubricants normally used. An example of such a composition is as follows. 1% by weight of the zinc salt of Tallöl is added to a Venezuelan oil distillate (aviation grade lubricating oil) refined with furfural, while heating to about 100° C.

A. E. Robertson. U.S.P. 2,232,868, 25.2.41. Appl. 4.5.38. Process for the production of a lubricating oil dye by heating a substantially adiphatic low boiling normally liquid saturated hydrocarbon at a temperature between 700° and 800° F. for a prolonged period in the presence of phosphorus pentoxide. Thereafter the catalyst is removed and the low boiling products distilled so as to collect the residue as a dye.

M. T. Flaxman. U.S.P. 2,233,203, 25.2.41. Appl. 3.5.38. Production of a lubricating oil for severe service internal combustion engines. The oil consists of a naphthenic base mineral lubricating oil containing 1–2% of an oil-soluble soap of rosin acids exclusive of those having "high grease setting properties." The soap has the property of controlling ring sticking in heavy duty internal combustion engines and does not impart substantial viscosity increase to the base oil in the stated amounts. H. B. M.

Detonation and Engines.

526.* An Analysis of Certain Characteristics of a Kadenacy Engine. Prof. S. J. Davies. *Engineering*, 1940, **149** (3880, 3882, and 3885), 515–517, 557–559, and 617–620.—A study is made of the general movement of gases through an opposed-piston two-stroke engine to which the Kadenacy principle had been applied. By means of a Sunbury cathode-ray indicator it was possible to obtain the pressure variations in the inlet system, working cylinder, and exhaust passage. Temperature and density measurements were not possible, and, in order to obtain complete mass-flow data, some assumptions were necessary.

Theoretical considerations lead to a basis for the calculation of the mass, velocity, and momentum at any moment of the gases flowing through the exhaust ports.

On the evidence deduced from the present tests the discharge process is elucidated. When the exhaust port opens, the time-area rate is sufficient to allow the exhaust gases to pass out with the high velocities measured and to impart their momentum to the external gases. There appeared to be no discontinuity between the retreating exhaust gases and the new charge entering the cylinder, and, during the greater part of the charging period, the pressure in the cylinder showed a depression of 0·5–1·0 pounds per sq. in.

The author concludes from his analysis that the so-called "ballistic" exit of the gases is the dominating factor in establishing the conditions leading to the direct charging of the cylinder, in this case from the atmosphere, through the admission port. J. G. W.

527. Patent on Detonation and Engines. W. G. Stephenson and G. G. D. de Coligny. U.S.P. 2,231,605, 11.2.41. Appl. 15.7.38. Method of improving the oxidation of a hydrocarbon distillate preparatory to its immediate introduction into the cylinder of an internal combustion engine. The liquid fuel is brought into contact in the presence of heat with a metallic catalyst; air is then added and the air–fuel mixture caused to flow in contact with another and different metallic catalyst in the presence of heat. Thereafter the air–fuel mixture is introduced into the engine cylinder.

H. B. M.

Coal and Shale.

528. Patent on Coal and Shale. A. L. Stillman. U.S.P. 2,231,513, 11.2.41. Appl. 5.11.38. Production of a stable liquid fuel having coal particles equally distributed throughout. The fuel is composed of a mixture of 40–70% by weight of a fuel oil and 60–30% by weight of coal of the bituminous type which has been subjected to a grinding action in the presence of the oil so that it passes 100% through a 325 mesh sieve.

E. S. Mead. U.S.P. 2,233,894, 4.3.41. Appl. 2.3.38. Preparation of a composite physically intermixed loose granular fuel mass of anthracite fines, comminuted bituminous coal and an oil binder. The oil binder constitutes from 3% to 5% of the total weight, the bituminous coal from 15% to 20%, and the balance is anthracite fines. The oil binder prevents segregation of the bituminous and anthracite particles, and acts as a combustible constituent of the mixture. H. B. M.

Economics and Statistics.

529. Survey of Fuel Consumption at Refineries in 1939. G. R. Hopkins. *U.S. Bur. Mines. Report of Investigations No.* 3554, February, 1941.—It is pointed out in this report that during 1939 a new record in fuel efficiency at petroleum refineries in the U.S.A. was established. During that year the average fuel requirement per barrel of crude oil refined was 557,000 B.t.u. as compared with 567,000 B.t.u. in 1938 and 562,000 B.t.u. in 1937. The gain in fuel economy was achieved by operating at a higher percentage of capacity and by utilizing improved methods and equipment, and was sustained in spite of increased percentage yields of cracked and polymerized gasoline. During the year under review there were no outstanding improvements in the technique of heat production at refineries, but numerous small economies were made. Fuel was saved by maintaining clean heating surfaces, by reducing excess air, by improving combustion, installing preheators, etc.

Analysis of types of fuel consumed during 1939 in refineries reveals an increase in fuel oil from 28,855,000 barrels in 1938 to 32,098,000 barrels in 1939, the whole of the gain being in California. The quantity of acid sludge utilized showed an unexpected gain of 542,000 barrels. There was a slight increase in coal consumption, but the ratio to total heat units declined from 2·84% in 1938 to 2·80% in 1939. Natural gas consumption again showed a decline, 97,685,000,000 cubic feet being used in 1939 as compared with 109,741,000,000 in 1938. Production of still gas increased in 1939, probably owing to increased cracking activities. Even though the amount of petroleum coke used as refinery fuel increased substantially in 1939 it represented only 7% of total output. Steam represented 1·3% of the total and purchased electricity, which has increased every year since data were first compiled, reached a total of 1,565,254,000 kilowatt hours, *i.e.* 12% more than in 1938. H. B. M.

BOOK REVIEWS.

Geophysical Prospecting for Oil. By L. L. Nettleton. Pp. xi + 444. McGraw-Hill Book Company, Inc., New York and London, 1940. Price 35*s*.

Of all branches of petroleum technology it is safe to say that none is more highly specialized and less generally understood than geophysics. In the first place this intimate blending of mathematics, physics, and geology calls for a particularly flexible type of mind, one as much at home with the inexact as with the exact sciences, a faculty possessed by few and hard to acquire.

The really expert geophysicist must have a flair for figures, be an expert manipulator of delicate apparatus, have clear vision in three dimensions, controlled imagination and, above all, a knowledge of the rocks. This is probably why geophysical prospecting for oil other than in outline is to all intents and purposes a closed book to many. Let it be said at once then that the author has succeeded in opening it, if not perhaps as wide as some geologists might wish, at least sufficient to rouse intelligent interest in a complex subject.

There is no question that the task of presenting geophysical methods to an audience of students or lay readers (for whom this book is primarily written) rather than to expert geophysicists, is no light one. It is made even more hazardous when designed as intended for those with geological rather than physical leanings. The author, however, is fortunate in combining a long practical experience of this form of prospecting with academic activities, and, in point of fact, his present work arises from courses of lectures given in the past to students of oil geology and engineering at Pittsburgh University. This, then, is the background of the book.

In our schooldays we were taught Newton's laws and something about the gravitational constant γ. We learnt of the work of Cavendish on measurements of Δ, the density of the earth, also about his torsion balance. We recall, too, in this connexion the advances made by Boys in determining γ. So, in the early stages of geophysical prospecting, an application of the torsion balance for gravitational surveys was at least intelligible on first principles, even if the methods of interpreting results were not. When the Eötvös Torsion Balance was introduced into the scheme of oil finding, we had to rub up our physics to understand just how this instrument could be used to locate subsurface structures, but it proved to be a complicated business.

Then came appeal to magnetic methods and, knowing something of the behaviour even of an ordinary compass in igneous as opposed to sedimentary fields, it was possible to appreciate the function of a delicate magnetometer in differentiating between rocks of varying sensitivity.

When electrical methods were introduced into oil exploration, notwithstanding their success with shallow mineral ore bodies, we were concerned to see how far they could be employed to determine electrical properties of rocks buried at really great depths below surface. Even now both theoretical and practical difficulties combine to limit the use of these methods to comparatively small depths, and it is clear from the text that much work remains to be done to improve their possibilities for locating really deep structures.

By far the most interesting weapon in the geophysical armoury is the "artificial earthquake" as it has been colloquially called. Just as a natural earth tremor is recorded on a seismograph, so measurements can be made of times of travel of earth waves set up by explosives at or near surface. These waves go out in all directions; some are refracted or reflected back to surface and are picked up by extremely sensitive detectors. The methods lend themselves in favourable circumstances to extremely accurate geological interpretation.

It is, then, with these four principal methods, gravitational, magnetic, electrical, and seismic, that this book is mainly concerned. Each subject is treated fully and separately. From enunciation of first principles the reader learns about the instruments employed, the measurements made, the calculations necessary and

the interpretations to be placed upon the results obtained. It is all done very well indeed and even the mathematics are not too formidable to the uninitiated when clarified by the author.

The final chapter on geophysical interpretation and the importance of the geophysical map is one which might well be read first. It is short but much to the point. It could have been expanded with advantage both to physicist and geologist. Here the author does not mince his words on the interpreter's "*ifs*," "ands," "buts," and "maybe's," but goes straight to the root of criticism of geophysical prospecting in emphasizing that complete co-ordination between geologist and geophysicist is not always reached, but is absolutely essential if the results are to be of practical value. After all, it is the geophysicist who makes the map, and the geologist who uses it or should do. No matter how brilliant the execution of the survey, it is little more than useless unless there can be drawn from it a reasonable picture of what is for ever hidden from view.

It is no good the geophysicist blaming the geologist or *vice versa* for sins of commission and omission when things go wrong and oil is not found. The author sums up the whole matter by a fervent hope expressed "for the day when a really competent combination of geologist and physicist will emerge in the same man who will be truly a 'geo-physicist' in all that the combined title implies." This end will in our view be furthered if oil geologists will give time to the teachings of this book and if physicists will detach themselves from figures and formulæ for a spell to read and learn from any standard geological text something about those "very dull-looking and superficially nondescript chunks of rock" (*sic*).

The author is to be congratulated on an excellent piece of work, on the concise manner in which he has put the subject matter together, and, not less, on a sense of humour disclosed in his last chapter, as refreshing as unexpected in a volume of this description.

H. B. MILNER.

A Handbook of Malaria Control. By R. Svensson. Pp. 73. Published by the Shell Group of Oil Companies. Unpriced.

Handbooks too often have little to commend them but their usefulness, but this small and compact book is pleasant to the eye and interesting to read. Compiled by the Ross Institute with the financial aid of the Shell Group, it is intended for the use of planters, engineers, and other laymen, who have to undertake anti-malarial work in the tropics. It is written clearly and concisely, and its material is so well arranged under sub-headings and in short chapters that reference is easy. At the same time the lively style makes the book excellent reading. Thus we are introduced to insecticides by the following delightful paragraph—"The swatter acts as a useful safety valve for tempers frayed to breaking point by the maddening persistance of insect pests, but it cannot be regarded as a weapon of major importance. Man's maturer response to the enemy within his gates is the insecticidal spray."

Malaria is a fascinating subject, and many of its aspects are touched upon. The enormous medical and economic importance of the disease, and the benefits that come from its control are stressed. The essential part which mosquitoes play in the dissemination of malara is well-known, but it is not generally realized that of the 1700 kinds of mosquito which exist only 17 species are dangerous carriers. Of these, some breed in fresh water and some in salt, some in swift streams and some in stagnant marshes, some in shade and some in sunlight. Adequate methods of control can be introduced only after a study of the habits of the local carrier has been made.

The various methods of control are surveyed. Breeding places may be treated to make them unsuitable for the local mosquito carrier. Attacks are made on the larvæ by Paris Green or by oil, and on the adult insects by sprays. Of particular interest to readers of this *Journal* is, of course, the section on Malariol. In the Introduction Sir Malcom Watson writes: "Oiling is *par excellence* our great standby in emergencies, even against larvæ living in running water, as I demonstrated in Malaya in 1914, and in many places is the method to be preferred for permanent use. The discovery of a perfect anti-malarial mixture proved of incalculable value to Malaya. I am thinking in terms of the saving of tens of thousands of lives and hundreds of thousands of pounds sterling."

We hesitate to offer any criticism at all of this fine production, but as we hope this will not be its last edition, we venture to record our regret that the date of publication is not given. Here and there the text is perhaps a little too condensed. For instance, it might be made clearer just what a " culicine " is and why it is necessary to distinguish it from an " anopheline " (chapter 3). The date of the introduction of Gambusia into New Ireland might be given (page 20), and the death rate rather than the number of deaths in Klang and Port Swettenham (page 1). These amplifications would make the data more instructive.

The author and the Ross Institute, the printers and publishers are to be congratulated on the production of this excellent book. It is to be hoped that the skill of the author and the generosity of the Shell Group will be rewarded by a wide and appreciative public.

M. L. JOHNSON.

Applied Mathematics in Chemical Engineering. By T. K. Sherwood and C. E. Reed. Pp. xi + 403. McGraw-Hill Book Company, New York and London. 1939. Price 28*s*.

There are books which cannot, or should not, be reviewed after a lapse of time since their publication. This is particularly the case with technological books dealing with industries, like the Chemical Industry, where research and development are proceeding at a very rapid pace. However, " Applied Mathematics in Chemical Engineering " belongs to the type which is stamped with a certain degree of permanence and which is expected to be re-issued in several editions as time passes. With the view of bringing this book to the notice of petroleum technologists who have not already made good friends with it and of bringing, on the other hand, to the notice of the authors certain suggestions should they be contemplating issuing a second edition, this review is presented.

The book as a whole reveals the authors' mastery not only of the subject matter, but also of the more difficult problem of presenting complex mathematical treatments and concepts to the chemical engineer, whose only standard of evaluating mathematical methods is their utility. They have hit on the happy plan in their treatment of complex functions of evolving the problem from the particular to the general first and then descending to the particular again, thus continuously being in touch with the practical applications of these mathematical methods. Thus after the first chapter, which is a review of differentiation and integration methods, the use of differential equations is gently brought to the full understanding of the reader. A problem is set as a first step, and it is solved in steps advancing from small finite increments to a simple differential equation. When the problem and the concepts it entails are thoroughly understood, the authors move to the general concept of mathematical origin of differential equations and then revert to the concrete by giving the physical origin of such formulæ.

If there is a criticism to be made in this connection, it is that there is a tendency to make the problems met " too easy " and in certain respects mechanical in character. Thus, in chapter 2, the general rule is laid for material balance, and the reader is urged to ignore the signs of input, output, and accumulation, provided he follows the formula. Of course, the solution to the problem is right; however, the encouragement of such rules robs mathematics of one of its chief characteristics—mental discipline.

Chapter 2 may be cited for another important generality which the authors reveal. It is the lucid manner in which they show the basic principles of mathematics which may be at the root of solving problems apparently entirely dissimilar and yet they are only variants of the functions of rates plus material and energy balance.

Chapter 3 deals with the solution of differential equations most likely to be met by chemical engineers. It is in reality a well-classified and progressive list of recommended procedures without undue explanations or proofs. Graphical and special methods are included. Although the chapter is in the abstract to a greater degree than the first two in the book, judiciously placed examples help to bring engineering realities to what would have been a purely mathematical summary.

Chapter 4 deals with the application of partial differentiation, and is by necessity a chapter on thermodynamics in so far as practical examples are given. It is to be hoped that in future editions, if extension of the book is at all contemplated,

these two chapters (3 and 4) shall be more in conformity with the others in that they will deal with a greater number of illustrative problems of practical importance. The powerful method of partial derivatives in Jacobian notation as used by Shaw in compiling his tabulated relationships of thermodynamical functions is an example of the artistry of the authors in presenting a really difficult and complex subject in lucid terms. Only once they used the term "it is clear"—and that when it was clear in reality.

Infinite series have a frightening effect on most "practical" technologists. Happily, the authors deal with these in the fifth chapter in their characteristic manner of setting a problem which leads in a natural way to the series. Thus, before the reader has time to be frightened he is in the thick of it, as it were, and has no time to worry! Bessel functions are introduced by following the solution, step by step, of a problem dealing with the temperature characteristics of a fin losing heat to the atmosphere by convection. The solution is given first by throwing the Bessel equation into a power series and evaluating the terms numerically and later by the use of the Bessel function directly.

Partial differential equations are discussed in the sixth chapter; but aside from the mathematical aspect, this chapter can be recommended as an excellent text on the elements and principles of heat conduction and of diffusion of gases. While the full treatment of the solutions to the general equation of heat conduction,

$$\frac{\partial t}{\partial \theta} = \frac{k}{c\rho}\left[\frac{\partial^2 t}{\partial x^2} + \frac{\partial^2 t}{\partial y^2} + \frac{\partial^2 t}{\partial z^2}\right],$$

is left to be pursued in texts especially devoted to the subject, sufficient is elucidated to be of value both to beginners and more enlightened students of this problem to justify thorough reading of this chapter. Schmidt's graphical method of solving problems in unsteady-state diffusion and heat conduction is specially mentioned by the authors in the preface, and the clarity of both the treatment of the general construction of the graphs and the illustrative examples is, therefore, as expected. However, a moot point exists in the problem dealing with the interdiffusion of equal quantities of helium and methane, each at 5 atmospheres, when a partition which confined them in the two halves of a long cylinder is removed instantly. It is assumed in the solution that the concentration of both gases at the central plane will instantly become 0·5 and remain so indefinitely. This will be true if Dalton's law is obtaining. Gilliland and others have shown, however, that when equal volumes of ethylene and argon, hydrogen and carbon monoxide, or nitrogen and methane, at 100 atmospheres each, are mixed there is an appreciable change in the pressure of the resultant mixture. If this event takes place in the case of helium and methane then surely the plane of equal concentration will move into the region richer in methane? Schmidt's method is still applicable, by following a moving instead of a stationary plane, if the rate of motion is known.

Chapter 7 is a summary of standard works on numerical analysis and deals with fitting equations to curves and determining the constants in such equations. One would only wish that somewhere in the book a place could be found where dimensional analysis could be treated in the terse yet explicit manner in which the method of least squares was treated in this chapter. Interpolation is adequately covered for all practical purposes: both Newton's and Lagrange's formulæ are given.

Graphical treatments are given in the eighth chapter. The discussion on misleading methods of correlating experimental data where certain functions are included in both co-ordinates to yield apparently regular correlations is particularly instructive. Triangular co-ordinates are studied in some detail and a section deals with alignment charts—the simpler straight line monographs.

The final chapter deals with theory of errors and precision of measurement. One felt continuously, while reading it, that the authors were pressed for space. The last portion of the chapter, however, tends to correct this impression, and the fact that 6 out of the 38 problems set in an appendix (to be solved by the student) deal with problems on errors rectifies it completely.

In conclusion, this book should be consulted by all who may have occasion to deal with design, development, costing, or similar problems in chemical engineering.

A. H. Nissan.

Applied Chemistry for Engineers. By Eric S. Gyngell, Ph.D., B.Sc. Pp. viii + 328. Edward Arnold & Co., 1940. Price 15*s*.

This book might have been entitled "Answers to Questions the Non-Specialist is likely to ask about Fuels and Combustion, Corrosion, Paint, Water Treatment, Sewage Disposal, Mortar, Cement and Concrete, and Lubrication."

The first half of the book is devoted to fuels and combustion, and, as is natural in an English work, the bulk of the information presented deals with coal and its derivatives. The classification and analysis of coals are extensively dealt with, and an adequate account of carbonization practice (coke-oven, gas works and low temperature) and the properties of the solid and gaseous products of carbonization follows.

A section on producer gas and other manufactured gaseous fuels leads up to three chapters on liquid fuels, in which a large proportion of the space is devoted to petroleum and its uses.

The information presented is extensive and covers the ground adequately from the general reader's point of view, but on certain subjects is unfortunately out-of-date and not free from factual errors.

It would be an advantage if in future editions the various sections dealing with petroleum refining, including that on lubricating oil manufacture in the final chapter of the book, were collected together and systematized.

The section on fuels concludes with an excellent chapter on combustion calculations. It is doubtful, though, whether there is any advantage in devoting several pages to two slightly different ways of computing weights of air required for combustion and of flue gases.

The second half of the book consists of condensed treatises on the other subjects mentioned in the reviewer's suggested alternative title. All can be thoroughly recommended.

In the chapter on "protective films" some mention of coslettizing and parkerizing might with advantage have been inserted alongside sherardizing (here spelt sheradizing) and calorizing, under "Miscellaneous methods."

A few other misprints were noted. These include Ried for Reid (p. 125) and hyphoid for hypoid (p. 313).

A term not previously encountered is "electrionic radiation," apparently synonymous with ultra-violet light, on p. 247. C. E. SPEARING.

PUBLICATION RECEIVED.

B.S.S. No. 743—1941 for Materials for Horizontal Damp-Proof Courses including Classification for Bituminous Damp-Proof Courses. (Revised March, 1941.) British Standards Institution, 28, Victoria Street, S.W.1. Price 2*s*. 3*d*.

The principal alterations included in this edition are: (1) a reduction in the minimum thickness of copper damp-proof courses, and (2) a re-arrangement of the clauses referring to the impregnating materials and the coating materials used in the manufacture of bituminous damp-proof courses with hessian base. The maximum amount of inert mineral admissible is not now stated, but the properties of the material are more exactly specified.

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Geology and Development.

530.* South Texas Still an Oil-producer of the Future. E. S. Post. *Oil Wkly*, 10.3.41, **101** (1), 33. The sixty counties of South-west Texas have been yielding new fields and new sands at the rate of 100 per year, and much development took place in 1940. On 1st January the unproduced but developed reserves stood at 1,458,515,899 brl., with production from 338 separate oil and distillate fields. This amounts to 7·8% of the U.S. reserve. Attempts have been made to assess deep possibilities, and on 1st March the chief play was on the Wilcox trend. Six fields have been found and dozens of geophysical prospects shot, and it is a case of deep exploration on an established trend, for previously most tests here stopped at the Yegua. The new work has led to exploration of the Cook Mt., Mt. Selman, and Carrizo levels, as well as the projected Wilcox, and sands have been opened in these zones. There has been exploration down to latest Ordovician, and virtually every zone has given production, leading to high hopes for deep development generally.

South Texas represents about a quarter of the Texas activity. A table shows that in the 5-year period to 1st January, 1941, South Texas reserves had improved from 2·6 to 7·8% of the U.S. reserves, and Texas reserves from 42·2 to 53·1%. 22·88% of all discoveries in U.S. in the above period were in South Texas. In 1940 Wilcox production was found in La Salle, Colorado, De Witt, and Live Oak counties, and in 1941 in Lavaca and Colorado counties; Mt. Selman production was found in Bee county.

Tables give the number of wells drilled, the footage and average depth, for U.S., Texas, South Texas and the Corpus Christi, Laredo and San Antonio districts of South Texas, for the years 1935–1940 inclusive. The reserves for South Texas are given for the Miocene–Oligocene, Jackson–Yegua–Cook Mt., Mt. Selman–Wilcox, Serpentine–Dale lime, Navarro–Taylor, Austin Chalk–Edwards, Glenrose–Ordovician for 1st January, 1935, 1st January, 1939, and 1st January, 1941, with the developed acres, expected yield/acre, estimated ultimate yield, cumulative recovery, remaining reserve, and the percentage of the South Texas reserves. G. D. H.

531.* South-west Texas Development, Production, and Reserve Data. Anon. *Oil Wkly*, 10.3.41, **101** (1), 36.—The data, given by counties and fields, include the following: discovery date, range of producing depths, producing formations, amount of acreage proved for oil and gas and that developed in oil, number of producing wells (those flowing and on artificial lift), daily output allowed, the cumulative production in barrels for the field and per acre, the 1940 production, estimated ultimate production for the field and per acre, the remaining reserve, greatest depth and the formation reached, the range of gravity, and the number of rigs running.

A map shows the locations of the 1940 discoveries—new fields, new sands, and extensions. G. D. H.

532.* Detailed Exploration Finds New Fields in Oklahoma. F. Taylor, *Oil Wkly*, 17.3.41, **101** (2), 26.—Early last year exploratory work was undertaken in Creek, West Okmulgee, North Hughes, East Seminole, and Okfuskee counties, and seventeen new fields have been found, despite the fact that the areas had been previously explored by the drill. Other areas in Oklahoma appear to merit re-examination.

The logs of old wells are being examined and their indications tested by the reflection seismograph, using twelve geophone locations between shot-points ¼ mile apart, a method which has given a high percentage of discoveries in Central Oklahoma in the

past few years. The Viola lime and the Wapanucka–Cromwell zone are probably the most generally used reflecting horizons.

The entire province throughout this part of Oklahoma is a monocline rising to the east and north, but interrupted by faults and anticlines and some unconformities and lenses. From the surface down to 5500 ft. the following possible producing horizons occur: Oswego lime, Prue, Calvin, Senora, Earlsboro, Booch and Gilcrease sands, Wapanucka lime, Cromwell and Misener sands, Hunton and Viola limes, Simpson dolomite, and Wilcox sand. Drilling is not very expensive in this region because of the moderate depths and comparatively favourable lithology, but there is a little trouble with high-pressure gas. Gas-injection is being practised at one point.

In Central Oklahoma some 6,704,000 brl. of reserves have been added since 1st January, 1940, by new fields, and 4,286,000 brl. by new horizons and extensions in old fields. 220 wells were completed in 1940. The oil is sulphur-free and paraffin base. There are some distillate fields in the Hunton lime. G. D. H.

533.* Venezuela : Pantepec and Standard have Production at Roble 4. Anon. *Oil Wkly*, 7.4.41, **101** (5), 63.—Roble 4 in the El Roble field has given 40·5° oil at the rate of 1078 brl./day on a ¾-inch choke from two sands at 9960–9990 ft. and 10,008–10,018 ft. Two upper levels at 9637–9677 ft. and 9735–9745 ft. have given oil at the rate of 1243 brl./day on the same choke. The gas/oil ratio was probably about 3000. Other wells have been located at El Roble.

Rincon Largo 1 on the Santa Ana structure is at 9124 ft., and Mercedes 1 in Guarico is at a depth of 5366 ft. G. D. H.

534.* New Well Indicated South of San Joaquin Area. Anon. *Oil Wkly*, 14.4.41, **101** (6), 59.—Santa Ana 3, 12 km. south-west of the San Joaquin area, has given 33·8-gravity oil at rates of 666, 1236, and 1722 brl./day through ½-, ¾-, and ½-in. chokes, respectively, in 4-hour tests. In each case the gas–oil ratio was under 900. The production is from the Periquito sand at 8320–8335 ft.

In Rincon Largo 1, on the Santa Ana structure, perforating at 8695–8985 ft. was unsuccessful, and perforations are to be made higher. Anaco 1 is at 8901 ft., after topping a thin oil sand at 8560 ft. G. D. H.

535.* Venezuela—Two Lower Pay Sections Tested in New Roble Well. Anon. *Oil Gas J.*, 6.3.41, **39** (43), 26.—3 Roble, ¾ ml. east of 1 Roble, has given 1291 brl. of 42° A.P.I. gravity oil through a ¾-in. choke from sands at 9627–9650 ft., and 936 brl. of the same gravity oil from three sands in the interval 9450–9530 ft. Both these pay sections are said to be lower than in the other two producing wells.

The Roble field is in Anzoategui, about 50 ml. north and a little west of Oficina. It gave 3000 brl./day during December and January, and is connected to the Oficina pipe-line. 4 Roble is at 9170 ft. and two other locations have been made. G. D. H.

536.* Kansas Activity Curve Upward as New Markets Open. R. Ingram. *Oil Gas J.*, 13.3.41. **39** (44), 12.—Exploration in Kansas has followed, with success, the general north-west trend of the Barton Arch (Central Kansas Uplift), and the cross-trends on the flanks. Fields have been found recently on both the north-east and south-west flanks, and the northernmost production at Ray has focussed attention on the Nebraska border region. Ray produces from the Reagan sand. Some wells have been sunk in South-west Nebraska.

Four new fields have been found and extensions made to producing areas since 1st January. The gain in activity has increased prorated wells from 5611 on 1st February, 1940 to 6713 on the same date this year. There was only a slight increase in the number of unprorated wells. Apparently the State's producing capacity has gone up 10–20% in the past year, and a commission has estimated it at 7,097,209 brl. There has been a continuous rise since the low of 148,000 brl./day at the beginning of May 1940. Since the middle of September 1940 it has hovered about 190,000 brl./day, with a peak of 207,000 brl./day at the end of February.

The use of 20-acre spacing is becoming general.

A map shows the geology of the Barton Arch roughly, and gives the sites of the fields. G. D. H.

537.* Leasing in Western Nebraska Developing into Major Play. W. V. Howard. *Oil Gas J.*, 20.3.41, **39** (45), 25.—Between 4,500,000 and 5,000,000 acres have been leased in Western Nebraska during the past months. Commencing in 1935 blocks were leased in Nebraska and the adjacent parts of Kansas, and small pools were opened. In 1940 the Ray pool was discovered in Kansas, Phillips County, and this revived interest. The oil was in a basal sand directly above the granite. Oil was also reported in the granite wash and showings in the Arbuckle. The leasing has been on the eastern and western sides of the Cambridge Arch, a probable continuation of the Barton Arch.

Following the discovery of oil shows in the Topeka series of Thomas County, Kansas, there has been leasing in Rawlins, Sheridan, and Decatur counties. A number of wells have been drilled or are under way, and data are given concerning these. The possible producing horizons are the Arbuckle, Chat, Kansas City-Lansing, etc., which are found bevelled off by erosion on the flanks of the arch, and the basal sandstone over the granite. Only the Upper Pennsylvanian or Permian beds cross the arch. The Morrison and Sundance wedge out on the west flank, and the latter, which produces in Wyoming, is viewed as a possible producer in this region. The Jurassic and Cretaceous beds rest unconformably on the older beds, thus masking the structures, and they themselves are often blanketed by Tertiary and Pleistocene beds. G. D. H.

538.* Hoodville Field Holds Attention of Illinois Operators. H. F. Simons. *Oil Gas J.*, 20.3.41, **39** (45), 34.—The Hoodville pool is now giving 12,000 brl. of oil/day and its production is rising. This pool lies 3 ml. south of McLeansboro. Ninety wells have been completed and twenty-one are drilling. Hoodville is one of a line of fields running south-east from the Salem field. It yields oil from the Benoist and Aux Vases sands. Its discovery well was completed in the McClosky lime at 3189–3200 ft., from which it flowed oil for only a few hours. A Fredonia test at 3154 ft. was similar, but the Benoist gave 353 brl. of oil in 24 hr. from 2947–2978 ft., after acidizing. All other attempts to get McGlosky production in this field have failed.

The Aux Vases sand ranges 3030 ft. to 3050 ft. in depth, and the Benoist 2931–2983 ft. The former sand gives wells averaging 250 brl. of oil/day; the latter gives wells averaging 200 brl./day. The former sand averages 15 ft. in thickness and the latter 18 ft. In some wells both horizons are produced at the same time. The structure may be large, and its eastern and southern limits have probably been partly defined by a number of dry wells. G. D. H.

539.* North Texas Drilling Most Active in State. D. H. Storment. *Oil Gas J.*, 6.3.41, **39** (43), 16.—In North Texas thirty-two new fields or producing horizons in old fields were added last year as a result of widespread exploratory work. The Fort Worth basin was the scene of the main activity, and yielded ten new fields or horizons in the lower Strawn and Bend series, but recently there has been a slackening of work as a result of failures. There are possibilities of widespread Ellenburger lime production in the south-west part of the K.M.A. field. This Ordovician production was discovered in April 1940. The horizon is a little over 4000 ft. deep, and an area of 1000 acres seems to have been proved productive.

The Hull-Silk field has ten horizons from the Canyon to the lower Strawn at 4650 ft. There are six horizons at Fargo down to the Ellenburger at 6717 ft., although, for economic reasons, most attention has been given to the 3250- and 3900-ft. pays. At Walnut Bend Strawn pays have been found at 4100 and 4700 ft., although earlier work was in two deeper Strawn pays and the deep Simpson and Ellenburger limes. Bonita seems to be the best 1940 discovery in the Fort Worth basin. It has twenty-one producers in either the 5200-ft. Bend conglomerate or the 5400-ft. Bend arkosic pay. Ringgold has Bend pays at 5693 and 5789 ft.

Although deep production was the main interest in 1940, the average well-completion depth was only 2650 ft., 350 ft. deeper than in 1939. The low allowables for deep wells and the lack of capital amongst the independent operators will restrict the number of 5000–6000 ft. wells, and the chief attention is still likely to be paid to the shallow sands. The shallow activity is largely confined to the trend of the Muenster arch in Cooke and Montague counties, and the axis of the Electra arch and the Bend flexure. It is mainly near the old fields. New pools, although small, are constantly being added. At Voth twenty wells have been drilled this year to the 1200- and 1600-ft. pays; near

Olney the 870-ft. sand is being sought by twelve rigs, and at Petrolia-Thornberry twenty-five rigs are drilling to the 1050-ft. Thomas pay and the 1250-ft. Gunsight pay.
G. D. H.

540.* Eastern Kentucky Active as Markets Expand. R. Sheldon. *Oil Gas J.*, 10.4.41, **39** (48), 8.—Eastern Kentucky gas-fields are supplying at least 30,000,000,000 cu. ft. of gas per year, and at present seventy-three wells are being drilled for gas in this area. The gas supply in West Virginia is diminishing rapidly, and its Oriskany sands are deeper (4500–5000 ft.) than the gas-bearing Devonian (2500–3000 ft.) of Eastern Kentucky. Gas has been developed in Pike, Martin, Floyd, and Knott counties (Eastern Kentucky), and development is expected in Letcher, Leslie, Bell, Knox, Jackson, and Clay counties.

In 1940 109 gas-wells, five oil-wells, and nine dry holes were completed in Eastern Kentucky. The oil comes from shallow sands, and from 6500 wells only 5500 brl./day are obtained.

Over 500,000 acres have been leased in Eastern Kentucky following the recent successes in deeper horizons in Illinois. Along the Paint Creek uplift are the Laurel, Mine Fork, Win, and Ivyton domes, all features of interest. Next in size comes the Rockcastle uplift. The Corniferous (Dev.), Clinton (Sil.), Trenton, and St. Peter (Ord.) and Knox dolomite are the horizons sought. In Leslie County oil-shows have been found in the Devonian, Silurian and Ordovician (Trenton). In a deep test on the Burke Dome (Elliott county) the St. Peter was at a depth of 3929 ft. Other deep tests are on the Paint Creek uplift near Oil Springs and on the Sinking Creek dome, Laurel County.
G. D. H.

541.* Year Looms as One of Best in History of Gulf Coast. N. Williams and F. L. Singleton. *Oil Gas J.*, 17.4.41, **39** (49), 40–41.—Sixteen new fields have been opened and new sands have been discovered in old fields on the Gulf Coast this year, and altogether this looks like being one of the best years in its history. There is concentrated wildcatting round the flanks of known salt domes, mainly on the Louisiana coast, search for deep-seated salt domes in the delta district of Louisiana, a wildcatting revival on the Wilcox trend and moderately extensive wildcatting round the flanks of the Agua Dulce and Stratton fields of Texas. Three of the year's discoveries were on the Lower Gulf Coast, eight on the Upper Texas Gulf Coast, and five on the Louisiana Gulf Coast. In the flank-drilling campaign distillate production has been found recently on the east flank of the Belle Isle dome. The Louisiana Gulf Coast still leads in deep drilling with 125 wells below 11,000 ft. and nine fields producing below that level. Many of the fifty-five fields discovered in the past three years are still in the early stages of development.

The Upper Texas Gulf Coast fields include Navidad, Maurbro, Vienna, West Garwood, West Hamman, Sabine Pass, Lakeview, and Chenango. They are mainly distillate fields. Five new fields have been opened in the inland bays adjoining the coastline. Many prospects have been leased on this coastal area, and they are expected to be tested soon.

Oil has been found on the flanks of the Agua Dulce–Stratton fields which were classed as gas-distillate structures.

The presence of deeper sands in the basal Frio has been established recently in the Luby field, whilst the discovery of the first commercial production in Willacy county has attracted wide attention to the Rio Grande embayment area. Geophysical work is said to have uncovered several promising prospects in that area.

At the end of March there were 15,220 producing wells in the three districts of the Gulf Coast giving 606,797 brl. of oil/day.
G. D. H.

542.* History of Gulf Coast: 40 Years of Brilliant Achievement. C. A. Warner. *Oil Gas J.*, 17.4.41, **39** (49), 64.—The Gulf Coast area of Texas and Louisiana has given about 9% of the U.S.A. production and its proven reserves are now estimated as 22% of the nation's total. Up to the end of 1940 545,926,000 brl. of oil had come from Louisiana, 1,318,703,000 brl. from the Upper Gulf Coast of Texas, and 269,102,000 brl. from the Lower Gulf Coast of Texas.

The beds dip generally coastwards, the dip increasing with depth due to thickening

and the incoming of other beds in that direction. The bulk of the production comes from true salt-dome fields or fields believed to overlie deeply buried salt masses. The rest comes from fold, fault, lens, and wedge-edge fields. Pliocene to Eocene sands and sandy shales give oil at depths from 190 ft. to more than 13,000 ft., twenty-three fields are producing at less than 1000 ft. and thirty-two at over 10,000 ft.

Oil from seeps was used as early as 1543, and there are numerous references to oil and the oil possibilities of this region prior to 1900. Various attempts were made to obtain production before 1900, and these are briefly described. The Spindletop discovery initiated a vigorous campaign of searching for oil on other similar surface features, leading to the finding of Saratoga, Sour Lake, and Jennings. In 1902 the overhang at Anse la Butte was drilled through to give oil beneath 500 ft. of salt. In 1903 Batson and Welsh came in, and in 1904 Big Hill and Kiser Hill. All the fourteen discoveries of the first decade of Gulf Coast production were the direct result of surface indications, and the same is true of the ten discoveries of the second decade. The history of some of these fields is outlined briefly, whilst the surface features are listed for all twenty-four.

Forty-four fields were discovered in the period 1921–1930. Surface geology had not given very satisfactory results, and most prospecting was therefore based on the various surface indications until geophysics entered the picture in 1922. The improved ability to find fields is shown by the discovery of 248 oil-fields in the period 1931–1940.

Amongst the important features of recent years are the increased depth of production, condensate fields, and the introduction of recycling and repressuring. The development of production has been supplemented by the construction of adequate pipe-line facilities and efficient refineries with a throughput capacity of over 1,000,000 brl. of oil/day. G. D. H.

543.* Producing Horizons of Coastal Sector of South Texas. J. C. Poole. *Oil Gas J.*, 17.4.41, **39** (49), 66.—Commercial gas was discovered in the coastal sector of South Texas in 1916, but the first oil well was not completed until 1925. The oil is obtained from sands of Oligocene and younger age. As a consequence of the many electrical logs available it is possible to divide the producing horizons into major divisions of sand series and groups which do not coincide with geological time divisions. At the base is the "Refugio sand series," variously named Frio, Vicksburg, Frio. Vicksburg, etc., according to the area. The "Sinton sand group" includes sands referred to as Frio, Upper Frio, and "so-called Frio." It wedges out up-dip, but down-dip there is a great thickness of sand bodies.

The "Greta sand series" was laid down by a transgressing sea. It is non-marine mainly and generally considered as Frio in age. The "Catahoula sand series" is mainly Miocene, but up-dip some of it is Middle Oligocene. It was deposited by a receding sea. The "Oakville sand series" produces gas chiefly and but little oil. It is of Miocene–Pliocene age.

A table lists the important fields producing from the Oligocene or younger beds in this area and the various sand series or groups which give oil in them, whilst the five main sand series are shown on a cross-section embodying electrical logs. A map is included. G. H. D.

544.* Bright Future in Prospect for Louisiana Development. J. Huner. *Oil Gas J.*, 17.4.41, **39** (49), 69.—Louisiana's oil production began in 1902 at Jennings, and to the end of 1940 it had amounted to 1,065,173,731 brl., with 103,065,698 brl. in 1940, placing it as sixth State for that year. On 1st July, 1940, the reserves were estimated at 1,210,895,921 brl., a rise of 425,183,788 brl. in six months. Twenty-one new fields were found in 1940.

Most of Louisiana's fields have a number of separate and distinct reservoirs. Thus Golden Meadow gives oil from nineteen sands. Many areas will be developed when accessibility is improved—*e.g.* the Atchafayala Basin.

Up to the end of 1940 536,088,575 brl. of oil had been recovered from the Miocene and Pliocene. In general, salt-dome cap-rock production is of relatively minor importance in Louisiana. The Pliocene sediments cover 11,000,000 acres and average 2000 ft. in thickness. Fifteen fields now produce from the Pliocene, the potential reserves of which are large and which has 219 prospects where the geological and

structural conditions are such that the expectation of Pliocene production is reasonable. In many instances there is already Miocene production below the Pliocene.

Most of Louisiana's production comes from the Miocene, in which there are now 120 fields. The Miocene is 15,000–18,000 ft. thick. The sands of the Upper Miocene, although numerous and thick, are not persistent. Few fields produce from only one sand. The sands are of high porosity and permeability. 220 sands of the Upper Miocene seem to have possibilities, and there are 209 prospects, some of which now produce from the Pliocene or Lower Miocene.

Thirty-four fields give oil at present from the Lower Miocene, where the sands range from 4 to 100 ft. in thickness and have a high porosity and permeability. There are 177 prospects, many now producing from the Upper Miocene.

The Cockfield, Sparta, and Wilcox reserves were estimated at 165,186,667 brl. on 1st July, 1940. The Cockfield has only three fields, all of which produce from the upper 100 ft., although there are shows in other sands. The Cockfield sands are continental and lenticular at outcrop, but become marine and extensive down-dip. There are 112 prospects.

The Sparta sand has provided only one field and some shows along the Sparta–Wilcox trend, but this may be due to inadequate testing. It resembles the Cockfield and Wilcox. Little interest was shown in the Wilcox until the discovery of the Eola field in 1939, and it has now eight fields. Production comes from at least two zones, and there appear to be deeper shows, whilst fifty-six prospects are known along the trend. Down-dip development has not been extensive, but the various marine stringers now apparent lead to the belief that a number of deeper Wilcox producing zones will be found. G. D. H.

545.* The Eocene Wilcox, with Special Reference to the Upper Gulf Coast of Texas. S. R. Casey. *Oil Gas J.*, 17.4.41, **39** (49), 74.—Many have sought the Wilcox section because it is largely composed of sand, and since the discovery of the Eola field, adding 75,000,000–80,000,000 barrels of oil to the reserves, the Wilcox trend has been "worked" with every available method of subsurface exploration. Before the beginning of 1940 there was Wilcox production in at least six Texas fields and three Louisiana fields. The first in Texas was the Clay Creek salt dome, yielding oil from the Middle and Upper Wilcox, and subsequently Kittrell, Joes Lake, Cleveland, Segno, and Ace added 100,000,000 brl. of recoverable oil to the reserves. In Louisiana Urania was probably the first Wilcox producer, followed by Ville Platte and Eola.

The Wilcox trend overlaps a part of the old "Conroe" or Cockfield trend, which was tested in 1934–1936, and in 1940 the Yegua data were extrapolated to the Wilcox. In the Texas coastal area thirty-five to forty wildcats were drilled, giving the Washburn, Thomaston, Sheridan, Cold Springs, and Lake Creek fields, and Providence City in 1941. Three Wilcox fields, Neal, Olla, and Jena were found in Louisiana.

New fields along the Wilcox trend are opening new types of oil- and gas-traps which have long been known as possibilities. Disconformities, nonconformities, sand anticlines, sand wedging, and strandline sands are being sought by the subsurface geologist.

The high producing qualities of the Wilcox make it an ideal objective for exploration. The trend covers parts of Texas, Louisiana, Mississippi, and Alabama, with oil production ranging from 1800 to over 10,000 ft. in depth. The Wilcox is generally assumed to be of deltaic or near-shore origin. Its sand sections are very irregular and difficult to correlate.

The production control in the new fields seems to include stratigraphic trapping with faulting (Neal, Eola, Joes Lake, Segno, and Sheridan), stratigraphic trapping (Urania, Olla, and Jena), and closure on the down-thrown side of a major fault (Magnolia). In the main the structural relief is small in these Wilcox fields.

A list gives some of the interesting Texas Wilcox wells in 1940, with the depths and dates of completions. G. D. H.

546.* Predict Discovery of Much Oil from Known Domes. C. Hagen. *Oil Gas J.*, 17.4.41, **39** (49), 82.—The period 1901–1923 covered the time from the discovery of oil on a Gulf-Coast salt dome to the introduction of geophysics. The early development depended on the interpretation of oil, gas and water seeps, topographical forms, etc. Drilling alone delineated the salt domes on discovery, and many dry holes were put down in the search for salt domes. However, thirty salt domes were discovered from

surface indications. Most of the oil was from Miocene and Pliocene sands, with the first flank production at Vinton in 1911. The drilling and testing methods were not good. Several salt domes discovered during this period have given over 20,000,000 brl. of oil to date—Spindletop, Humble, Batson, Saratoga, Barbers Hill, Hull, Sour Lake, West Columbia, Orange, Goose Creek, Jennings, New Iberia, and Vinton.

The introduction of geophysics in the 1923–1934 period led to the discovery of many salt domes. The reflection seismograph permitted the detailing of the structures, and overhangs were determinable by the refraction method. Flank production came to the fore, well samples were handled more ably, and drilling and production practices were improved. Considerable amounts of Oligocene oil were discovered and some development of Eocene sands took place. Spindletop (deep), Humble (deep), Sugarland, East Hackberry, Lake Barre, Caillou Island, Leeville, and Cameron Meadows were the fields found which are expected to have ultimate recoveries exceeding 20,000,000 brl.

From 1934 to date the vast potentialities of salt domes have been recognized, and these include stratigraphic traps and the features associated with non-piercement domes. Electrical logging and directional drilling have made salt-dome development less treacherous and less hazardous. Improved drilling and production practices, particularly better control of heaving shale, have made 10,000 ft. holes common.

With the declining rate of discovery of new and less obvious geophysically determinable structures on the Gulf Coast, the exploration and development of known piercement type salt domes will be carried on in future with increased intensity. Refined seismograph profiling on the flanks will provide better knowledge of dips, faults, and structural conditions. Many faults can be traced or found in shallow holes. The prime importance of good well records is already recognized. The residual "highs" between rim synclines will probably be sought, and no doubt much new oil will be obtained from known salt domes. G. D. H.

547.* Maritime Development Certain to Assume More Importance. F. L. Singleton. *Oil Gas J.*, 17.4.41, **39** (49), 96.—Recently a second oil-field in the Gulf of Mexico was discovered offshore from Jefferson county, Texas. For several years marine development has largely been confined to the development of structures in marshlands and inland bays along the Louisiana Gulf Coast. The new field lies nearly 2 ml. offshore and gives Miocene production from 4982 to 4992 ft. at the rate of 5 brl./hr., the oil being of 26·7° gravity. This structure was worked over geophysically, and three wells have been drilled. The other field is 1 ml. offshore from Cameron parish, Louisiana. Drilling is expected to be resumed on a salt dome at McFaddin Beach, offshore from Jefferson County, where there have been several failures, the deepest having been abandoned at 7600 ft. In Galveston Bay are several structures, of which three have proved productive. Cedar Point gives oil from the Frio at 4400 ft. and 5900–6000 ft. On the Red Reef prospect, 6 ml. to the south-east, gas-distillate production was discovered in the basal Frio at 8814–8815 ft., and oil wells have also been completed. The structure is extremely faulted, with a number of producing sands between 8800 and 10,300 ft. The Fisher's Reef prospect, 9 ml. to the north, found oil at 8961–8963 ft. in the Frio, but testing is suspended. Preparations have been made to drill 1½ ml. offshore from the Bay Marchand area, Louisiana, and at points 10 ml. south-east and 8 ml. south of Seadrift. Oil showings were found on the Mud Island prospect in Aransas bay. Gas and a little distillate were found at 7840–7850 ft. in a St. Charles Bay test.

Nine discoveries have been recorded in marine development in the Gulf of Mexico, and they include Caplen, Bird Island, and Baffins Bay, East Flour Bluff, and the Corpus Christi gas-field. G. D. H.

548.* Complete Report of Gulf-Coast Operations by Fields. Anon. *Oil Gas J.*, 17.4.41, **39** (49), 114.—Under the district headings of Laredo, Lower Gulf Coast, Upper Gulf Coast, Western Louisiana Gulf Coast, and Eastern Louisiana Gulf Coast the fields are listed alphabetically with the following information: discovery month and year; number of producing wells at the beginning of February 1941, and daily average production on that date; cumulative production to the end of 1940; number of active operations; producing depth and formation; gravity of oil and pipe-line outlet.

Maps are given of the various districts. G. D. H.

549.* Hawkins Field Valuable Addition to Nation's Reserves. M. T. Halbouty. *World Petrol.*, Feb. 1941, **12** (2), 24.—The Hawkins field lies about 12 ml. west of the Gladewater district of the East Texas field. It was located geophysically, and three producers have now been completed. The closure is about 800 ft., with the upper 100 ft. containing gas and the next 400 ft. oil. Production is from the Woodbine at a depth of 4390–4790 ft., the total thickness of sand in the section aggregating about 145 ft. It appears to be under water drive, and has a bottom-hole pressure of 2026 lb./in^2. The recoverable oil, of 28–29° gravity, is estimated at 750 brl./acre-ft., and the area of the field may be 7500–8000 acres. A spacing of 20 acres per well has been fixed. Sands down to 1400 ft. carry fresh water, whilst the Nacatoch and Blossom sands have salt water.

The reserve at Hawkins is estimated to be 562,500,000 brl., as compared with 5,000,000,000 brl. at East Texas initially. East Texas has a maximum effective sand thickness of over 100 ft., and an area of 150,000 acres, on which 26,000 wells have been drilled. G. D. H.

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550. The New Oil Region between the Volga and the Urals. N. Polutoff. *Oel u. Kohle*, 1940, **36** (13), 113–117; **36** (15), 137–140.—During the past ten years a series of important oilfields has been discovered between the Ural Mts. and the Volga, and so far they have yielded more than 4,000,000 tons of oil. The number of prospective structures exceeds 100, and the discovery of new gas- and oil-fields continues.

The new oil province occupies the eastern edge of the East Russian Depression which lies immediately to the west of the Urals. Geological work there is hampered by the fact that the revision of the old divisions of the Carboniferous and the Permian is not yet completed, and so correlation between various deposits is not always possible. The tectonics of the region are characterized by north to south uplifts, which can be traced from the Vyatka river in the north to the Donets river in the south. Oil-shows in the form of asphalt and asphaltic limestone have long been known.

The most important fields occur in the Bashkirian Republic, the largest producers in the whole of the Volga–Ural oil province being found in the Ishimbaevo area. Production comes from Upper Carboniferous–Lower Permian limestones, which form buried hills the origin of which is attributed by some to reef formation and by others to tectonic forces. Six of these structures have been discovered, five being exploited. Geological conditions suggest that they extend all along the west slopes of the Urals, from Ishimbaevo to Chussovskie Gorodkie, with the exception of the area covered by the Ufa Plateau. Particulars of the various oil-fields and occurrences are given, as well as some details of the developments in the Tuimasy area, some 150 km. west of Ufa.

The oldest field in the Perm district is Chussovskie Gorodkie, 70 km. north-east of Perm. The oil comes from limestones which are similar in age and structure to those in the Ishimbaevo area. Exploration there has been abandoned since 1934. A new field, located on the south-west end of a large structure, the Krasnokamsk-Polasna anticlinale, was discovered in 1934 at Krasnokamsk, 40 km. west of Perm. A number of other fields have been developed on subsidiary structures. To the north of Perm oil-shows have been found in many borings in the Cherdyn and Solikamsk district, the oil at Solikamsk possibly being associated with salt-stocks.

The oil deposits of the Kuibyshev region lie within the area of the Samarskaja Luka, a sharp bend in the Volga between Stavropol, Kuibyshev, and Syzran. The two main pools are at Syzran and Stavropol, and both produce from the Carboniferous. There are other structures in the area related to the same tectonic feature.

In the Chkalowsk region there are occurrences at Buguruslan and Novostepanovka, both of which are being developed and both of which produce from the Permian. The situation of the Buguruslan occurrence, between Tuimasy and Samarskaja Luka, suggests that Carboniferous oil must occur there also.

No exploitable occurrences of oil are yet known in the Tartar Republic, although shows are numerous. This is also true of the Saratov and Kirov regions, but suitable structures have been mapped, and exploratory drilling is being carried out.

Apart from the Ishimbaevo area, where the oil is at shallow depths and the wells very productive, most of the fields produce from 800 to 1200 m. The individual production of the wells is smaller than at Ishimbaevo, but the fields are much more extensive. In deposits of the Buguruslan type considerable quantities of oil are

obtained from depths of 260–300 m., and in spite of low production per well, the exploitation of these deposits is profitable.

According to the 5-year plan, the Volga-Ural oil province is to produce 7,000,000 tons in 1942. S. E. C.

Geophysics and Geochemistry.

551. Seismic Investigations at the Geophysical Institute, Göttingen. XXXIX. Derivation of Absorption Coefficients Independent of Frequency from Engine Vibrations. O. Förtsch. *Z. Geophys.*, 1940, **16** (1/2), 57–84.—In previously published work the absorption coefficient has been calculated from the formula for propagation of earth vibrations of sine-wave form, the distances being measured in metres. The coefficients so obtained are strongly influenced by the frequency and velocity of propagation of the vibrations. This influence disappears, however, if one substitutes wave-length as a measure of distance, and the absorption then becomes solely a characteristic of the earth through which the vibration travels. Theoretical considerations and practical work which was carried out around Göttingen are discussed. From an analysis of the measurements made the following additional facts emerge. Machine-made vibrations are plane-propagated. The absorption coefficient is determined not only by the stratum carrying the vibration, but by the whole vibrating subsurface. If the waves are propagated simultaneously in two strata, the same absorption coefficient is valid for both. Earth vibrations which have a frequency close to the natural frequency of the rock are considerably less absorbed than others. S. E. C.

552. Seismic Investigations at the Geophysical Institute, Göttingen. XXXVIII. Investigations of the Elastic Properties of Rock Prisms. W. Regula. *Z. Geophys.*, 1940, **16** (1/2), 40–56.—Prisms of brass, marble, slate, and granite, 20 cms. long and 1 cm. square in cross-section, were cemented to a depth of 4 cms. in the concrete floor of the "Erdbebenhaus" at Göttingen. In order to give these short prisms a reasonable frequency, they were loaded with lead. Both static and dynamic measurements of the moduli were made, and it was found there were considerable variations between the two sets. The main cause of this was stretch, and the influence of stretch and of cross-sectional deformation in prisms of square cross-section were investigated. The results of the measurements are tabulated. The Poisson Constant was calculated from the elasticity and shearing moduli. Hysteresis, both in the case of bending and of torsion, was also investigated. The results show that, if we except the case of torsional hysteresis, even small samples of rock may be treated as isotropic from the point of view of elasticity. S. E. C.

553.* New Advances Broaden Use of Geochemical Prospecting. Anon. *Oil Wkly.*, 14.4.41, **101** (6), 34.—Geochemical prospecting is expected to play an important part in future oil and gas discovery, especially in the search for marginally low-relief structures and stratigraphic traps which will be sought more and more as structural prospects are drilled.

There are two broad classes of geochemical manifestations of a petroleum accumulation—near surface effects, and near deposit effects. The former fall in the province of soil analysis and give data regarding the position and areal extent of the accumulation, but no depth data; the latter—geochemical well-log data—give information of the nearness of the accumulation.

The possibility of accumulation can now be estimated for 500–1000 ft. of undrilled sediment beneath the bit, and there are also lateral indications. Well-cuttings are used, taken at 30 ft. intervals. After determining the water content of a small sample, sufficient to give 100 gm. of dry cuttings is extracted. The extracted gases are analysed by a combination of low-pressure, low-temperature fractionation and combustion methods. Three gas fractions are separated: (1) that not condensable at — 190° C. (air, methane, and hydrogen); (2) that boiling between — 190° and — 145° C. (ethane, propane, butane); (3) pentane and higher. Hydrogen seems to have maxima some distance above the oil-sand. The hydrocarbons have maxima at the sands, and non-producing wells have very low hydrocarbon concentrations. The best data are obtained from the less permeable formations rather than the potential reservoir rocks.

Two geochemical logs are given. There seems to be a straight-line relationship between the gravity of the oil and the distance above the deposit at which the first strong indication is encountered.

In soil analysis it is believed that absolutely impervious strata are probably non-existent. Usually hydrogen, methane, ethane, butane, propane, and the heavier saturated hydrocarbons are separated and identified quantitatively, in addition to certain inorganic materials and hydrocarbon polymers. There is debate as to whether the magnitude of the surface geochemical anomaly is a measure of the depth of the oil accumulation. G. D. H.

Drilling.

554.* Choice of Drilling Equipment. V. J. Beissinger. *Oil Wkly*, 24.3.41, **101** (3), 21. *Paper presented before American Petroleum Institute.*—The mechanics and economy of drilling operations are affected by such factors as programme, power, and cost. Fundamentally, cost relationships and effects are truly realistic, and the most advantageous choice of drilling equipment may be substantiated by the cost of its ultimate performance. In order to obtain conclusive regional expression for the most basic cost determinations, the writer suggests the pooling of individual company drilling-experience records. By such co-ordinated effort full information in the light of full perspective could be obtained. While this paper stipulates the nature and importance of the factors which influence the choice of drilling equipment, the relative weight of these criteria must be determined by much more detailed investigations.

By pooling of drilling-performance information, regional as well as local drilling factors could be set up for general industry use, so that the consideration of drilling equipment would be on a basis similar in scope to the design of casing strings and the application of areal production formulæ. Variations in drilling programmes, as well as differences in power-plant and equipment power-consumption economics, could be catalogued on the basis of oil-industry experience to the extent that the choice of drilling equipment would be facilitated by an inspection of correlated reliable facts and figures. Because the cost of drilling equipment is the ultimate measure of its utility value, the most direct approach to the proposition of selection is along some line of comparable standards of value. A measure of useful life in terms analogous to the work performed has been suggested. Until the industry accepts some such standards as indicative factors of use and performance, there will not be a sufficiently common reference base for any practical consideration of useful selection. A. H. N.

555.* Crown and Travelling Block Design Meets Deep Hole Need. E. Sterrett. *Oil Wkly*, 7.4.47. **101** (5), 15–26.—Crown and travelling blocks, rigidly held to fixed overall size by existing derrick conditions, meet deep-drilling demands by using high-tensile materials, ingenious sheave and bearing arrangement, and with stepped-up units to distribute concentrated bearing and running loads over precision-formed areas capable of meeting maximum stresses through long operating life.

The fleet angles formed by reeved lines, as distinct from that of the live line, are more serious from the point of sheave and line wear than the one which continually changes—that between the blocks varying in value, but always forming in the same direction, and affecting in each phase the same short section of the wire line.

Reduction of this transitory fleet angle is secured in modern blocks by holding sheave thickness to a minimum, by ranking them in two decks in the crown block and placing them in tandem rows in the travelling block, and by setting two of the crown-block sheaves with their axes at right angles to the others in the block, thus equipping the two sheaves to serve as cross-over units and permitting the lines to be brought back or set so that the resultant fleet angles are opposed.

Capsizing effect, as well as the fleet angle between corresponding sheaves of the two blocks, are both inherent in the commonly used " spiral " reeving used in either left- or right-hand string-ups when five- or six-sheave blocks are loaded to capacity. Both these load-distribution factors are anticipated and well covered in newer designs by additions to usual safety factors and the provision of greater bearing capacities.

Relatively soft sheaves, with consequent corrugated grooves to amplify rope wear, have been entirely superseded in the heavier types with special alloy steels, susceptible of hardening through heat treatment until the contacting surfaces of sheave and wire

rope resist equally the abrading effects of service, wind-borne grit, and tangential chafing due to fleet angle misalignment. Fully heat-treated sheaves, of special alloy steel to develop desired toughness under heating and quenching, fitted to accurately machined and ground bearing races, permit a high-quality groove finish. These sheaves, balanced both statically and dynamically, deliver a service life many times that secured from earlier designs under much lighter load ratings.

Fluid lubrication of sheave bearings in the heavier units has been almost superseded by pressure-gun-grease systems. Each bearing, being self-contained and enclosed with grease retainers, is fed from a separate fitting in the end of the drum or shaft on which the bearings are carried. Where solid pins are employed, these grease-lines are bored within the metal, with laterals at right angles to the bearing sites. On the larger units, where a hollow drum provides adequate support for the bearing races, an end-plate carries the grease nipples, with flexible conduits to the individual bearings. The use of small pipe formerly employed for this purpose, has been practically discontinued, due to its tendency to work apart under vibration, and to divert needed lubricant from the bearings to the interior of the drum.

Trend of block design is towards simplification; more complete unitization of each sheave and all its bearing components, in which more widespread use of pressed-in outer races, instead of employing the inner face of the hub for this service, is indicated; and specification of materials susceptible of having incorporated in them, through heat treatment and flame hardening, lasting wearing surfaces which will eliminate reworking until the service life of the unit involved has been exhausted.

This extensive paper is illustrated with photographs of representative blocks, each of which is described in detail. A. H. N.

556.* Recover over Mile of Drill Pipe against Difficult Odds. N. X. Lyon. *Oil Wkly*, 7.4.41, **101** (5), 28.—A combination of sulphur gas, brine, and high pressures constituted one of the major troubles in drill-pipe recovery work. In going in and coming out of the hole brine flowed in torrents, and the sulphur gas rendered necessary periodic shut-downs for fresh air. A pair of rubber gloves ordinarily became worthless during one operation of pulling out or going into the hole, due to reaction of the salt and sulphur.

To add to the difficulties, badly fractured drill stem boxes, and in some cases completely parted pipe, were found. This is believed to have been due to the combination of sulphur gas, brine, and pressures, which set up a crystallization action that split the boxes, causing fractures the width of an ordinary pencil and complete parting of the pipe at the boxes in some instances.

The break-up of the pipe at the boxes probably prevented full recovery of the pipe-string. That recovery to 6400 ft. was obtained under conditions experienced is regarded as exceptional, for the pipe recovered had forty-seven splits. Bridges both inside and outside the drill pipe baulked attempts to circulate mud, so the entire fishing operation had to be carried on without benefit of even partial control with mud. Approximately 1344 ft. of pipe remains in the hole. It is believed to be completely trapped by bridging and to be unrecoverable due to the countless splits and fractures in the pipe-boxes.

Details of the recovery operations are given. After recovering many sections, side-tracking was used. Mud troubles are described with the methods used to overcome them.

This well—Bateson 1—is the first attempted deep well in the Michigan basin, and on its completion are hinged in no small measure the starting of two or more other deep wells this year. Without question the gas-distillate pay at 7776 ft. offers encouragement for deeper beds in Michigan, but it is not entirely adequate proof. Production is from an unclassified bed of the predominately salt zones of the Salina. Many geologists believe that the high pressures and low volume of gas are indicative of salt production. A. H. N.

557.* Relationship of Drilling Contractor to Oil Operator. A. Rowan. *Oil Wkly*, 7.4.41. **101** (5), 36. *Paper presented before American Petroleum Institute.*—The relationship of the drilling contractor to the operator is substantially that of the employee to the employer. Practically all drilling contracts are made on the basis of what is known as a footage contract. The contractor makes the hole and performs the

labour necessary to set the pipe and complete the well, and the operator furnishes the materials and special services, such as cementing, electrical logging, etc.

In considering the price to be paid a contractor for his work, it should be borne in mind that the contractor has no control over the price he pays for supplies, such as wire lines, drill pipe, drilling bits, and other necessary repairs to his equipment. His only control over cost is in the wages which he pays his employees, and the efficiency of these employees in the conduct of their work, so as not to abuse his equipment, but instead to operate them in the most economical way possible. The care and selection of these employees are of the utmost importance, not only to the operator, but also to the contractor. These employees, including the tool-pusher, are really the employees of the operator, since they are taking orders from him—possibly not directly but through the contractor—and the efficient execution of their work is of prime importance to the operator.

In the operation of drilling rigs, if a contractor can operate his drilling rigs in a given field on a continuous basis—*i.e.*, locations waiting before the completion of the well on which he is then working—his costs will be materially less than if each well is finished and a period of time then elapses before the commencement of another. Likewise, if a contractor can operate two or more rigs in a given field, his operating costs are lessened. In both these instances the contractor passes, or should pass, these savings on to the operator by reducing the contract price per foot.

The function of the contractor is to perform the work required by the operator in a first-class, workman-like manner, and at a cost comparable with that of the operator if he ran his own tools, taking into consideration, of course, all elements of such cost. These should include proper charges for depreciation, obsolescence, overhead, and supervision, and also camp facilities for his employees, annuities, insurance, etc., together with any other benefits given to his employees, and hazard. With the proper co-operation between contractor and operator this can be done, the resulting advantage to the operator being the elimination of invested capital and decrease in number of employees and possible labour troubles. The contractor, being a small organization, can probably run his organization with less likelihood of labour trouble than the operator, because of the personal contact with his men.

Other items are discussed. A. H. N.

558.* Wells Slightly Deeper in 1941 and Footage Relatively Large. Anon. *Oil Wkly*, 21.4.41, **101** (7), 22.—Wells drilled in the first three months of 1941 were slightly deeper, on the average, than those completed in the corresponding months of 1940. Consequently, total footage drilled has continued relatively large, having fallen short of that for last year only by about the same small proportion as completions have lagged.

Comparative data for the interval 1925–1941 are presented for number of wells completed, total footage drilled, and average depth/well for each year. A. H. N.

559.* New Methods and Equipment Lower Drilling Costs. A. F. Lager. *Oil Wkly*, 21.4.41, **101** (7), 26. *Paper presented before American Petroleum Institute.*—The paper deals in particular with practices in the Illinois Basin, and, because the rotary is the main system used, the discussion is entirely confined to this type of rig. In general, the Illinois Basin has offered many opportunities for detailed bit studies, and it can be pointed out that the result of the combined efforts of operators and manufacturers alike has been to reduce bit costs as much as 50%. In reducing such costs the penetration rate/bit has been materially increased, all of which have combined to place Illinois rotary drilling on a cost basis comparable to other areas.

As might be expected, the abrasive nature of the formations causes severe erosion action on the body of the drill-pipe and tool-joints. Ordinarily the life of drill-pipe and tool-joints is about the same, and a commonly accepted figure in the Mid-Continent is from 75,000 to 100,000 ft. However, in the Illinois field it was found during the early drilling that it was necessary to replace tool-joints at from 15,000 to 20,000 ft. and to retire the drill-pipe at 40,000–50,000 ft. Therefore the drill-pipe usually consumed three to four sets of tool-joints. In an endeavour to correct this condition several steps have been taken with beneficial results. Surface rebuilding of tool-joints employing ribbons of steel or welded sleeves are being used, which greatly reduces the cost of repairs.

One of the most important contributions to rotary drilling in Illinois has been the development of field-applied tool-joints. In the past it has always been necessary to haul drill-pipe to a machine shop for bucking off and bucking on new tool-joints. New shrink grip-joints have been developed which can be applied to drill-pipe on location without the necessity of machine-shop labour and equipment. Although no actual data are available, it is believed that better costs can be attained through the use of replaceable joints than by rebuilding or hard facing worn joints.

The development of hydraulic torque converters for use in driving rotaries is a notable advance made during the last two years, and is finding favour among operators. Through its use an infinite number of speeds are obtainable, with instant application of maximum power when needed.

The problem of lost circulation is being more efficiently handled through the use of a newly developed instrument for finding fluid levels in the holes after circulation has been lost, and in checking the placement of cement so that some of the slurry is left in the hole and the rest placed immediately around the well-bore.

A pressure core-barrel is being used experimentally in the area at the present time. The purpose of this type of barrel is to recover a core which is as nearly as possible in its original condition. A. H. N.

560.* California Operators set Fast Drilling Time. L. P. Stockman. *Oil Gas J.*, 13.3.41, **39** (44), 37.—Various records are described for fast drilling and completion. For instance, in the Ten Section field, Shell Oil Co. showed an average of 412 ft./day total elapsed time in Kern County Land, which was finished at 8235 ft., but it must be remembered that in this total time the company landed surface pipe, a combination oil string and 2-in. tubing and had the well on production in twenty days. The actual footage average was about 451 ft. daily, exclusive of time spent in cementing.

The fastest drilling time on record was made in the Wilmington field of Los Angeles Basin by the Kern Drilling Co., which on a night tour made 1595 ft. in 8 hrs. for an average of 199·3 ft./hr. A depth of 2713 ft. was reached in 40 hrs., and this included an electrical survey, directional survey, mud conditioning, and running casing which consumed 14 hrs. The 40 hrs. drilling time to 2713 ft. also included the landing of 8¼-in. casing as a water string at 2710 ft. Actual time on bottom of the hole approximated 25 hrs. as far as actual drilling is concerned.

Other interesting data are included for different fields of California. A. H. N.

561.* Maintenance and Operation of Rotary Drilling Lines. H. F. Simons. *Oil Gas J.*, 13.3.41, **39** (44), 39.—The fact that no money is being made by a rotary drilling rig when the bit is off bottom has led drillers to operate the hoist at maximum speed while making a trip. The later-type rigs are capable of high drum speeds and have a capacity for over 6000 ft./min.

Such speeds frequently lead to many complications which affect the efficiency and service of the wire rope. About 4000 ft./min. is the maximum speed at which the line will spool smoothly and evenly; when this rate is exceeded there is danger of balling up and overlapping on the drum, particularly if the blocks are not loaded.

Running long strings of pipe in the hole at high speeds is also dangerous, for if the bit strikes a shelf or tight place in the hole, the line will continue to unreel until the drum rotation is stopped by the driller applying the brake. If the pipe then becomes free it will drop until the slack is taken out of the line. The momentum of the drop may exceed the breaking strength of the line if too much slack was run off the drum. A preformed line has greater flexibility and less tendency to twist under light loads and high speeds.

Many operating hints are given. For instance, in cutting a new line an even number of coils or half-coils should never be removed. Rather the amount of the line cut off the drum should be so many coils and a fraction of a coil, one-fourth and three-fourths being the best. This changes the portion of the line at the major and minor cross-over of each coil. Cutting on the even or the half-coil will not change the cross-over points, and part of the purpose of changing the position of the line will be defeated. The periodic and systematic changing of the position of the wire rope on the drum is the most important means open to the drilling contractor of lengthening the life of the drilling line.

When a new wire rope is being placed on a drum, or the ends of line already in service are being interchanged, the new rope or section should be loaded gradually and should see as much mild service as possible before it is subjected to heavy loads. This practice is to pull all but ten or twelve stands of pipe (manufacturers recommend the former, while drillers generally use the latter) from the hole and then perform the change-over. The wire rope thus has ample time to adjust itself before it is heavily loaded.

Because of the risk to human life and property involved, it is considered dangerous to run a rope having a safety factor less than 3·75. This represents 75% of the strength of a wire rope having a safety factor of 5 when installed. Some wire ropes when new have a greater safety factor than this, and can consequently be used with a smaller percentage of the remaining strength.

The simplest way to obtain all the necessary information for estimating the remaining strength is to count and list the broken wires by strands. Wire Engineering presents several re-roping charts for different types of ropes for use in other industries. These may be used for the construction of charts for wire ropes used in drilling service.

A. H. N.

562.* Repair of Surface Casing on Rotary Drilling Wells. H. F. Simons. *Oil Gas J.*, 20.3.41, **39** (45), 54.—Various reasons for failure in surface pipes are discussed, ranging from improper installation and operation to accidental causes. Generally failure in the surface pipe occurs suddenly and without warning. If the break is in the upper portion, the first sign will be a reduction in the mud in the flow-line, whilst the cellar will begin to fill up and mud will start flowing around under the derrick floor. Breaks in the lower portion of the pipe will cause a binding of the drill-stem, or may not be noticed until the bit fouls on the broken-off portion as the drill-pipe is being pulled from the hole.

Repair of an upper break is rather simple, the top portion of the pipe being pulled from the hole and a die collar or nipple installed on it. The top portion can then be screwed into the lower and cement pumped down around the outside of the casing to reinforce it. If the top portion cannot be pulled from the hole, a bridge can be placed in the lower section and cement squeezed through the break. The pipe should be centred to insure a good job.

If the bottom section has not fallen down the hole, it can be re-centred and then cemented in place. For centring the pipe a long spear can be made from a tree or timber, with a groove cut down one side to permit passage of the cement. This may be run on the bottom of the drill-pipe or below a pack-off tool, which will force the cement downward and around the loose section of pipe. The same method can be used to cement in place a section of surface casing which has fallen a considerable distance.

A new method of repairing such breaks was introduced during the past year. It was originally designed to repair producing string or casing, the bottom portion of the string having fallen down the hole while a window was being cut opposite an upper producing section. It has since been used to repair several surface-casing breaks.

The objective is the return of fallen suction-pipe to its original position, centring it in the hole and then cementing it in place. A cement retainer is modified so that it becomes a casing spear in addition to a means of forcing drilling fluid and cement slurry around the pipe.

A. H. N.

563.* Refrigerated Mud Proposed for Overcoming Heaving Shale. C. P. Bowie and R. V. Higgins. *Oil Gas J.*, 20.3.41, **39** (45), 60.—The use of oil as a drilling fluid in heaving shale localities is discussed. The authors believe that a more satisfactory and less expensive drilling fluid would be a " water-in-oil " emulsion in which the water phase is a refrigerant, such as calcium chloride. This could be a " loose " emulsion containing a small quantity of oil and wall-building material and a large quantity of refrigerant, as the two fluids would be agitated during drilling operations and would therefore not separate. It may not be necessary to use an emulsion, as a mixture of oil and water does not flow nearly as readily through porous mediums—the formation or the mud cake on the wall—as do single-phase liquids.

Experiments by the authors indicate that it should be possible to prepare a satisfactory fluid without the use of oil. One such fluid consisted of 25 parts by weight of calcium chloride, 75 of water, and 29 of a good wall-building commercial clay. The

Stormer viscosity of the fluid was 23·6 centipoises and the weight 11 lb./gall. A Union Oil type of filter press, 3 in. in diameter, was used. It was surrounded by a cold kerosene bath. Under a differential air pressure of 100 lb./sq. in., 12 c.c. of calcium chloride solution came through the press in the first 20 mins. when the temperature was — 5·0° F. This amount of fluid is smaller than normally flows from the average field mud when tested in such a press at room temperature, notwithstanding the fact that calcium chloride would flocculate the colloidal content of the mud. The thickness of the mud cake was about 1/16 in.

It is noted that the wall-building properties of clays rich in colloids are enhanced as the temperature of the drilling fluid is reduced. This becomes particularly apparent when the temperature approaches the freezing point of water.

The cost of a portable refrigerating plant suitable for refrigerating the drilling fluid is estimated to be $55,000. Such a plant could be moved from place to place and used again and again.

In introducing this system of drilling some changes will be necessary in the usual drilling technique. These changes are discussed in this paper. None of them seems to offer any particular difficulty.

Manufacturers of refrigerating equipment and operators of refrigerating plants, who have been consulted, are agreed that the application of refrigeration to drilling such formations, from their viewpoint, presents no unusual problem. A. H. N.

564.* Current Practices in Maritime and Water-Bed Drilling. P. Oldenburg. *Oil Gas J.*, 17.4.41, **39** (49), 72.—The use of a submersible drilling barge is ideal in open yet protected-water locations where the depth of the water ranges from 5 to 10 ft. In such places the barge is easily moved about and no excavation of channels is necessary, and yet it is protected from high seas. If a field has once been established in a marshy section by using piling for foundation for the first few wells, a great deal of saving can be accomplished by establishing a series of canals and moving a drilling barge into the locality to complete the drilling programme. It may be roughly estimated that the cost of a drilling barge and power barge is equivalent to the cost of seven to eight piling foundations, drilling equipment excluded in both cases. While there is very little saving to a piling foundation the drilling barge is moved intact from place to place.

The development of diesel, and especially diesel-electric power has proved of great value to marine drilling. It puts much less demand on supply of fuel and water. An ordinary diesel-electric power plant with adequate storage facilities will require only one or two monthly replenishments of fuel oil. Fresh water used in the cooling system is cooled by sea-water in heat exchangers. Since marine drilling must necessarily depend on water transportation for its supplies, any method which will reduce this to a minimum will raise the efficiency of the entire undertaking. Direct current is generated by the diesel-electric power plant, which is utilized through cable transmission on the drilling barge to operate the electrically driven pumps, draw-works, and rotary table. Through a switchboard any combination of power may be had if desired to concentrate or divide this power, thus giving the entire system much flexibility. Once the drilling is actually under way it does not differ greatly from any other type of rotary operation on a land location.

In marine drilling safety precautions assume even greater importance than in land drilling; blow-outs and fires are much more serious. Safety methods are described. A. H. N.

565.* Marked Improvement Shown in Deep-Drilling Technique. N. Williams. *Oil Gas J.*, 17.4.41, **39** (49), 88.—The paper deals particularly with Gulf Coast practices. Contributing to the increased problems and difficulties of deeper drilling are such conditions as greater gas pressures, high-pressure salt-water flows, excessive temperatures, and heaving shale. These not only create complications in direct control of wells during drilling and completion, but accentuate the hazards involved in such normal mechanical requirements as coring, directional surveys, and drill-stem tests. This is particularly true in attempting to reach an objective below 10,000 ft. with only surface casing in the hole or with small-diameter pipe as a secondary or protection string. So far as heaving shale is concerned, operators for the most part are inclined to discourage attempting to drill deep wells in known heaving-shale zones.

In this extensive paper the author deals with many of the usual hazards during drilling, cementing, and completion of deep wells. Improvements of equipment and a greater knowledge of its application and fuller realization of the importance of conditioning and controlling the mud flush have been major factors in the progress made on the Gulf Coast in meeting the problems and minimizing the hazards of deeper drilling. Improvements in equipment, both in size and adequacy and in quality of materials, have made possible more effective and efficient operation and have lessened the chances of mechanical failures and break-downs at critical times. Better mud conditioning has provided more effective control of formational conditions at the point of inception of trouble. A. H. N.

566.* Methods to Recover Stuck Drill-Pipe. Anon. *Oil Gas J.*, 17.4.41, **39** (49), 149.—Dependent on conditions, three methods of recovering stuck drill-pipe may be resorted to—viz., spotting or circulating oil, inside cutting, and washing over together with outside cutting.

Drill-pipe may freeze while attempting to control an active well when movement of the pipe is limited. Again, the pipe may stick while pulling out, due to an unknown groove in the wall or the balling up of reamers used prior to running casing. In such cases, particularly the latter two, circulation may be established.

Where it is definitely known that the pipe is stuck at or near the bottom of the string, the inside cutting method usually saves considerable time and expense in completing the operation. The cutting tool is run on 1¼-in. or 2⅜-in. flush drill-pipe, and will cut 3½-in. internal flush, 4½-in. and larger drill-pipe. In cutting the 4½-in. size the tool-joints must be the full-hole type, to permit passage of the cutter. Extreme care must be exercised in operation because of the fragile nature of the cutters in small tools.

In the majority of cases where drill-pipe freezes or sticks, the method of washing over and outside cutting is generally preferred, and meets with a greater percentage of success than the other two methods. Various factors are responsible for this preference, chief of which is that the drill-pipe sticks more often when combating an active well and surface casing is the only protective string.

With modern types of casing and outside cutters in use, this method of recovery in a normal-size hole is successful. Cuts as long as 900 ft. have been made by some operators, although generally it is considered preferable not to take cuts longer than 600 ft., due to the possibility of dropping the fish while pulling out, and thus complicating an undesirable situation.

Side-tracking and milling from bottom up are also described. A. H. N.

567.* Drilling Shallow Wells Profitably in the North Texas Area. H. L. Flood, *Petrol. Engr*, April 1941, **12** (7), 80.—The paper deals in particular with the problems of the "small" drilling contractor, and describes a one-engine portable rig which is being used to solve the financial side of these problems. The unique feature of the entire assembly is the single 165-h.p. engine used to supply power for the entire operation. It is also interesting to note that only one mud-pump is available in drilling with this rig. The entire assembly, including a 65-ft. telescoping mast, is mounted on a single skid that permits the rig to be moved as a unit on a heavy-duty truck. The units are fixed in place, and thus are always in perfect alignment, and no time is lost in lining-up after a move is made. Total weight of the rig is 47,000 lb. When highway requirements prohibit this weight or special permits cannot be obtained, or when the going is soft underfoot, the engine and pump can be moved separately on their respective skids.

Various modifications in the conventional type of rig have been used. As an example of ingenuity, the owners of this rig, adjusting their methods to the local field conditions, have eliminated the drilling of a rat-hole to receive the kelly, and are laying the kelly down while a trip is made. This innovation is justifiable in this instance because the top 50 or 60 ft. of drilling in the field is hard rock digging. Offset operators, adhering to the practice of drilling a rat-hole, consume 18–24 hrs. for the operation, the time required to drill 25–30% of the rotary hole.

The single mud pump used on the rig is of the modern outside-crank type with heavy-duty tapered roller bearings on the crankshaft and crank-pins. The maximum liner size is 6 in. and the stroke is 12 in. The fluid chamber is recommended for a maximum

discharge working pressure of 1800 lb./sq. in. tested to 3000 lb./sq. in hydrostatic pressure. At maximum operating speed of 65 r.p.m., when equipped with full-size liners, theoretical displacement of the pump is 364 gal./min. and recommended maximum brake horse-power input is 129. The one-piece semi-steel fluid end of the pump is of the direct-flow type with no internal walls subject to internal pressures.

A. H. N.

568.* California Practice in Casing Deep Wells. W. A. Sawdon. *Petrol. Engr*, April 1941, **12** (7), 86.—Many of the long strings now being run are " tailor-made " to fit the specific well conditions. Many of these strings are made up with a bottom section of N-80 pipe, a middle section of J-55 pipe, and a top section of N-80. No definite ratio of N-80 and J-55 pipe can be stated, but the average will probably be about 50% of each, whether the J-55 is on top or in the middle. By placing the N-80 on the bottom of the string the greater strength is used against collapse; by placing the N-80 on top the greatest tensile strength is obtained where most needed. Examples are given in detail.

A considerable amount of special casing is being used for long strings in California. The chief features of many of these makes of special casing are in the joint design or in the strength of the coupling material. The use of high-tensile-strength couplings allows a reduced O.D. with more clearance at the joint. The pipe itself is frequently made of a special alloy steel that may exceed A.P.I. specifications.

In determining the stretch to allow, consideration must be given to the fact that the string will weigh less in a hole full of mud, even with the inside full, and that after the string has been cemented the entire string is not hanging. Moreover, under some formation conditions the casing may not be free for some distance above the top of the cement, and this will further shorten the distance over which the stretch is effective. One suggestion has been made that the weight of the string before cementing, as read on the weight indicator, be noted, and that this weight-reading be used when setting the casing in the slips after the cement job is completed.

If too much tension is taken on the pipe the string will be too taut and the whipping of the drill-pipe may cause it to break. Subsequent cooling may also cause additional stretch to such a degree that the metal will fail. In one well, for example, a heavier gas-flow than expected was encountered when drilling-in, and after the production of the well declined the cooling effect from the expansion of the gas caused the pipe to part at the top joint. The stress at the point of highest tension should not be allowed to exceed two-thirds of the yield point of the pipe.

When the string is landed with insufficient stretch the casing will hang too loosely in the hole, and may wobble during subsequent operations. There is then the hazard of the pipe breaking near the top of the string. The A.P.I. round threads now generally used withstand wobble, but when the wobble is excessive they will not prevent breaking at the coupling.

Cementing problems are also discussed. A. H. N.

569.* Current Drilling Practice in the Texas Panhandle. H. L. Flood, *Petrol. Engr*, April 1941, **12** (7), 92.—It has been, and probably will continue to be, standard practice in the Panhandle to complete the wells with cable tools, whether rotary or cable tools have been used to drill from the surface to set casing.

One company has had fair success drilling into the dolomite with rotary, using the lightest weight mud possible and getting " in and out " of the formation as quickly as possible. Difficulty is usually encountered, however, after the formation is shot with explosives to open up the relatively dense oolitic rock. If the hole can be completely bailed-out prior to the shot, removing all mud and water, and the shot tamped satisfactorily, it is believed the use of rotary may increase for drilling dolomite wells.

Another company has recently drilled a number of gas wells using rotary all the way and employing gas as the circulating medium to remove cuttings from the hole. This method is apparently satisfactory, and may be adopted more widely in drilling gas wells, despite the many objections to the method now being expressed. It is not believed, however, that gas circulation can be made to apply in drilling oil wells.

Thus far there is apparently no method whereby rotary can be used to complete oil wells, particularly in the Granite wash. It is possible that the present developments

in California and elsewhere, involving the use of chemicals to reduce surface tension and to dissolve mud and other plugging materials, may eventually be effective as a solution for this problem of flooding the formation with mud and water.

An analysis of the cost of operating a light rotary rig of the portable rig, employing a three-man crew, indicates a monthly cost of $10,312, including a depreciation charge of 3½%/month on the rig. In the Pampa area, drilling three 3100-ft. wells/month, the unit cost of drilling is therefore $1.11/ft. This compares favourably as an average with the $1.05/ft. cost of one of the leading slim-hole operators in the Panhandle.

It is a coincidence in the Texas Panhandle that the water level in each porous formation occurs at or close to sea-level. Above the water-level a zone of oil occurs, and the upper portions of the anticlinal folds contain gas only. Consequently, it is only necessary for the porous horizon in a well to be encountered above sea-level to be productive of oil or gas. The amount of production then depends solely on the local porosity.

The rock pressure is uniform in the Panhandle, but is sub-normal, being less than half the normal hydrostatic head. The controlling factor determining this pressure anomaly is not definitely known. The decline in pressure from the initial rock pressure of 430 lb./sq. in for the field as a whole has been greatest in the areas developed for oil.

A. H. N.

570. Directional Drilling. Anon. *Mining & Geol. Mag.*, March 1941, **2**, (4), 250—251. —A brief review of the development of the Eastman directional drilling method and illustrations of its employment in controlling large well-fires. B. M. H. T.

571. Patents on Drilling. C. E. Reed. U.S.P. 2,234,197 and 2,234,198, 11.3.41. Appl. 13.12.38 and 24.3.39, respectively. Earth-boring apparatus, each being a rotary drill-bit utilizing a special cutter mounted in a specific manner.

D. D. Anderson. U.S.P. 2,234,219, 11.3.41. Appl. 1.2.40. Reamer consisting of a body with a recess in its side in which a cylindrical cutter is mounted.

C. E. Lang. U.S.P. 2,234,264, 11.3.41. Appl. 21.11.38. Core-drill with a core-barrel which is movable in a vertical direction.

J. V. Pennington. U.S.P. 2,234,273, 11.3.41. Appl. 19.2.40. Rock-bit cutter with laminated relatively soft tough material and hard laminæ to form the cutter teeth.

J. C. Stokes. U.S.P. 2,234,286, 11.3.41. Appl. 29.2.40. Core-catcher with a plurality of flexible arms.

J. A. Muller. U.S.P. 2,234,350, 11.3.41. Appl. 15.7.39. Hose and coupling structure.

G. L. Kothny. U.S.P. 2,234,438, 11.3.41. Appl. 18.4.40. Tool-removing device to remove whipstocks from bore-holes.

H. F. Richter. U.S.P. 2,234,454, 11.3.41. Appl. 20.5.40. Apparatus for drilling wells consisting of squared-section drill-pipes with passages for intake and outtake of fluid.

S. W. Craig. U.S.P. 2,234,798, 11.3.41. Appl. 29.1.40. Mud-line pressure-control valve.

B. B. Smith. U.S.P. 2,234,811, 11.3.41. Appl. 9.7.37. Cathead drum.

A. Boynton. U.S.P. 2,234,957, 18.3.41. Appl. 28.10.38. Thread locking means in a tool-joint.

J. S. Morgan, Jr. U.S.P. 2,235,080, 18.3.41. Appl. 21.12.35. Draw-work.

J. D. Spalding. U.S.P. 2,235,088. 18.3.41. Appl. 12.2.40. Draw-work.

T. S. Bunker. U.S.P. 2,235,279, 18.3.41. Appl. 21.11.29. Weight indicator for deep-well drilling-rigs.

E. P. Halliburton. U.S.A. 2,235,318, 18.3.41. Appl. 6.6.40. Apparatus for cementing wells, including packers and non-return valves.

J. F. Bozeman. U.S.P. 2,235,548, 18.3.41. Appl. 1.4.40. Bit for drilling well-bores by the rotary system.

F. I. McConnell. U.S.P. 2,235,770, 18.3.41. Appl. 16.8.37. Method of determining the volume of a lower uncased portion of a well provided with the usual casing and tubing, by means of forcing the well liquids into the formation, putting in well a light non-penetrating liquid, and allowing well-liquid to return from formation, and then withdrawing excess of non-penetrating liquid.

W. J. Crites and P. C. Murphy. U.S.P. 2,237,387, 8.4.41. Appl. 28.6.39. Drilling barge fitted with piling members which are anchored by pumping water in them.

J. F. Smith. U.S.P. 2,237,394, 8.4.41. Appl. 27.2.39. Oil-well rig-power transmission apparatus, adapted for use under conditions wherein the relation between the load torque and the input torque is subject to sudden changes.

H. E. Grau. U.S.P. 2,237,427, 8.4.41. Appl. 1.7.40. Pipe-tong support.

J. A. Zublin. U.S.P. 2,237,538, 8.4.41. Appl. 25.2.39. Swedge adapted to be lowered to a point remote from the surface in a casing set in a well.

B. S. Minor. U.S.P. 2,237,683, 8.4.41. Appl. 24.4.39. Method and apparatus for suspending well-casing.

R. Parr. U.S.P. 2,237,686, 8.4.41. Appl. 23.6.39. Bailer of the suction type.

E. O. Lowe. U.S.P. 2,237,709, 8.4.41. Appl. 5.2.40. Blow-out preventer.

W. A. Shaw, and A. O. A. Hodge. U.S.P. 2,237,715, 8.4.41. Appl. 18.12.39. Rotary swivel.

A. Kendrick. U.S.P. 2,237,965, 8.4.41. Appl. 19.3.38. Structural steel tower to be used as a derrick.

J. J. Whalen. U.S.P. 2,238,199, 15.4.41. Appl. 2.1.40. Rotary drill-bit with a magazine of cutter teeth which feeds the teeth into a holder only when previously fed teeth are worn out and useless.

E. S. Strang. U.S.P. 2,238,377, 15.4.41. Appl. 9.9.39. Under-cutter adapted to be mounted on a drill pipe.

J. E. Reed. U.S.P. 2,238,398, 15.4.41. Appl. 22.5.37. Line-spoole which is a guide for damping vibrations in a long span of travelling cable.

B. W. Sewell. U.S.P. 2,238,609, 15.4.41. Appl. 21.4.39. Pressure core barrel for rotary coring systems.

A. R. Maier. U.S.P. 2,238,654, 15.4.41. Appl. 27.2.40. Swivel for rotary drilling.

R. L. Ohls. U.S.P. 2,238,706, 15.4.41. Appl. 12.10.39. Tool-joint with the male and female portions fitting by a non-rotary motion. A. H. N.

Production.

572.* Pressure Maintenance Yielding Beneficial Results at Kermit. D. H. Stormont. *Oil Gas J.*, 13.3.41. **39** (44), 32–34.—In a low-pressure area in the Kermit field of West Texas highly satisfactory results are being obtained from a pressure-maintenance project—the first undertaken in West Texas. To date over 4,719,314,000 cu. ft. of gas has been returned to the producing formation, with the result that a number of wells previously not capable of making their allowables are now doing so, and wells that were on artificial lift are now flowing their production. Other favourable results obtained include a check in the decline of bottom-hole pressures, a rise in the fluid

level, and decrease in gas–oil ratios of some wells, and the checking of water encroachment in at least one well.

The Magnolia project differs from usual pressure-maintenance and repressuring operations in that the pay-zone into which the gas is being returned is composed of lenticular sands, some producing oil and gas and others producing only gas. To make the project even more difficult, practically all wells involved had been given heavy shots of nitroglycerin on completion. This makes it impossible to run liners and shut off the gas-bearing sands, or use of other mechanical methods that will permit gas injection into only the desired oil-producing sands. Thus control of the gas-drive, on the whole, must be accomplished solely from the surface through proper selection of gas-injection wells and constant control of the gas-injection volumes.

Each of the seven injection wells is equipped with a pressure-reducer regulator, a volume-flow controller, and a recording thermometer. The pressure regulator, of course, reduces the line pressure of the gas to the desired injection pressure. In the event of the flow controllers on some input wells freezing, the regulators were installed to prevent one well from "hogging" all gas.

All injection wells were thoroughly cleansed before gas was started into them. All cavings were removed from the hole and any paraffin accumulation removed from the face of the pay. The latter was necessary to avoid possibility of the high-pressure gas forcing the paraffin into the pay-sands and thereby interfering with gas-flow into the producing sands.

In conclusion it is stated that sufficient time has not yet elapsed for a complete study of the field. A. H. N.

573.* Pressure-Maintenance Projects under way in Permian Basin. D. H. Stormont. *Oil Gas J.*, 13.3.41, **39** (44), 34.—This short paper deals with four of the five projects in the Permian Basin. As an example, gas is being returned to the Yates sand-pay at 2032–2100 ft. through three input wells at the rate of 150,000–300,000 cu. ft./well. Gas is taken at 15–20 lb. from the field separators, compressed to 150 lb. in the first stage of two 165-h.p. units, and discharged at 1000 lb. on the high side. Injection pressures vary from 425 to 1000 lb.

Gas return has not been carried on sufficiently long to show maximum results, but the leases have shown favourable response to the operations. Bottom-hole-pressure surveys in April and September 1940 showed drops of from 15 to 40 lb. during the period, as compared with declines of 150–200 lb. in surrounding leases. One key well in a low-pressure area of the lease on a recent test showed a bottom-hole pressure of 325 lb., whilst an offsetting producer on another property tested only 175 lb. In several wells production has been increased, with resulting lower gas–oil ratios. Some of the high-pressure gas is being used for gas intermitting in seven lift wells. The remainder of the seventeen wells are flowing, the only ones in the field.

Data for the other projects are also included. A. H. N.

574.* Salt-Water Injection in East Texas at Important Stage. G. Weber. *Oil Gas J.*, 13.3.41, **39** (44), 36.—A review is given of experiments and studies in brine disposal into the Woodbine sand to solve problems both of disposal and of flooding. Tests employing wells on the south edge of the field, either former producers or specially drilled wells, were made. Some experimenting was done in injecting salt water to the lower section of the sand, in a well which was kept on production through the annular space, employing a packer below the oil section.

Out of this diversified investigation, the open system of handling salt water at the surface, and injection into re-worked, specially equipped input wells has evolved as the most generally accepted method at the present time. Salt water is gathered and passed through stepped-trough sections, accomplishing sufficient aeration to cause precipitation of iron oxides. Settling-tanks are provided to remove much of the solids, and filtration after settling renders the salt water sufficiently free of solids to prevent clogging in the sand.

Of the thirty-four injection wells in use during January, most were taking water at a vacuum, with no well-head pressure required to force the salt water into the formation. In some cases, however, pressure is required, sometimes temporarily to "break down" the formation, after which lower pressure or gravity is required for flow. Building up of back pressure has been combated in several cases simply by back-washing and

flushing or swabbing the wells to remove what is believed to be filter-cake on the face of the sand. This is apparently caused by bacterial action, or in some cases possibly by lack of sufficient settling time at the surface. Longer settling time has improved operations and treating in others. Treating is restricted mainly to the use of chlorine, alum, or lime for bacterial control, and has not been found necessary in all cases.

A. H. N.

575.* Flowing Practices in Flooding at Nowata. P. Reed. *Oil Gas J.*, 13.3.41, **39** (44), 48.—A distinctive feature of producing oil by the water-flood method in the Nowata, Oklahoma, field is the practice of lifting oil in producing wells by flowing. Up to the time the water-flood boom started in Nowata in 1936 it had been common practice to pump water-flooded production.

With present flowing methods, principal operating expense for the property in the latter stages of the flood's life is the cost of power for pumping water into injection wells. There is no expense for treating and filtering, because the water used for injection is brine-produced with oil on nearby properties. This brine is injected without treating and filtering, under the same pressure used on freshwater-injection lines on adjacent portions of the flood. Because of the manner in which it is operated, this property is commonly referred to in the area as a salt-water-disposal project.

With the rapid-depletion method of operating water-flood projects it is possible to return the original investment in the shortest time and to maintain a higher yearly income.

A longer period of water-flood operation is advocated by a number of independent operators. It is believed that with the longer period of flooding the ultimate recovery will be greater although the yearly recovery may be less. These operators prefer to exploit as effectively as possible. Properties offering the most favourable conditions for water-flooding are not readily acquired.

While there has been a growing practice in Nowata towards flowing producing wells, flowing is far from being the universal method for bringing oil to the surface in the area; since a substantial part of it is lifted by wells pumped by central powers and electric motor-driven jacks.

A. H. N.

576.* Injection of Gas in Lime. P. Reed. *Oil Gas J.*, 20.3.41, **39** (45), 48.—A report of the unusual practice of injecting gas into a small oil-producing lime formation is presented. Gas is injected, mostly from one well, by a small compressor driven by a 25-h.p. gas-engine of a type commonly used for pumping powers. This equipment is operated at capacity all the time, and injects gas at a pressure of 280 lb. This pressure has been maintained for the past two years. Before that the pressure maintained was between 340 and 350 lb.

As a result of gas injection, the decline of production has been checked sufficiently to justify the application of gas injection on the property. The oil has a gravity of 32° A.P.I. Complete data regarding the amounts of oil produced and of gas injected have not been made available for publication. For the last two years production has been maintained at approximately 25 brls./day from the wells on the property. In reviewing what has been accomplished by this experiment, it has been found that the decline of production in the last 5 years has been sufficiently checked to make it possible to operate profitably a property which could not have been paid out under normal conditions.

A. H. N.

577.* Inspection of Tubular Goods and Sucker-Rods. H. M. Henderson. *Oil Gas J.*, 20.3.41, **39** (45), 50. *Paper presented before American Petroleum Institute.*—A diagram shows an arrangement of an instrument in a section of a tubing and the manner in which it operates to detect the worn spots and the extent of the reduction of wall thickness. The instrument is set, before running into the tubing, to indicate when the remaining wall thickness is less than a given amount. For example, if it is set to indicate a remaining wall thickness of less than $\frac{1}{4}$ in., no electrical contact is made unless the remaining wall at any point throughout the length measured is less than this amount. The actual wall thickness may be any amount between $\frac{1}{4}$ in. and the full thickness of new pipe if no electrical contact is made. In other words, the instrument only indicates if the remaining wall is less than the amount for which the instrument is set.

By resetting the instrument to indicate other remaining wall thicknesses, tubing may be segregated into different classes and utilized to the most economical advantage.

The instrument does not measure the actual wall thickness of the pipe, but indicates the inside diameter opposite each one of the fingers. The remaining wall thickness is determined by comparison of this diameter with the normal o.d. of the pipe. Commonly used settings of the instrument are for $\frac{3}{16}$, $\frac{5}{32}$, and $\frac{1}{4}$ in. remaining wall in order that tubing may be classified sufficiently for proper segregation.

When surveying tubing on the rack, an " electrical buzzer " indicates the existence of a worn area, whilst a strip recorder with pen records the length and depth of worn area in the tubing when a survey is conducted in a well. To determine the length of the worn area in tubing surveyed on the rack, the operator notes the distance the instrument is moved while the buzzer is buzzing.

In order that the entire circumference of the tubing be surveyed without the necessity of rotating the instrument, contact fingers are spaced at $\frac{3}{4}$-in. intervals around the circumference of the tool, and these will detect a worn spot as small as $\frac{1}{4}$ in. in width.

For inspecting sucker-rods an instrument is described which classifies rods on removal from the well so as to eliminate potentially dangerous sections. The operation of the instrument depends on the magnetic properties of the material in the sucker-rod. The sucker-rods are drawn through the instrument as they are raised from the well. This assembly contains a group of primary coils which surround the rod and are energized by an electric current drawn from an A.C. motor generator set mounted on the truck, which also carries the recording instruments. A set of pick-up coils which surround the rod are also carried in the well-head assembly. A voltage is generated in the pick-up coils by the magnetic field which is induced in the sucker-rod by the energized primary coils, and it is the variation in this voltage which is indicated by the recording instrument.

Similarly, a telescopic instrument for inspecting the internal surface of drill-pipe is described. A. H. N.

578.* Multiple Hydraulic Pumping in Illinois Oil-Fields. H. F. Simons. *Oil Gas J.*, 10.4.41, **39** (48), 30–31.—While most of the pumping in Illinois is by the beam method, in recent months there have been several leases equipped with fluid-driven bottom-hole pumps. This type pump has been used for a number of years in deeper production and in fields where large volumes of fluid needed to be handled. The method in Illinois consists of installing a central power plant and then running power-oil lines to the individual wells. In this manner one power unit is used for lifting the oil from as many as twelve wells and as few as two wells.

Essentials of the system include a surface pump which supplies power oil through a macaroni string to a reciprocating pump at the bottom of the well. The exhaust from the power cylinder is into the tubing, and the used power oil is brought to the surface with the production.

The pumps are run inside the tubing on the macaroni string in the same way as an ordinary insert pump is run in on a rod-string. The pump is retrieved from the bottom by pulling the power-string. A seat in the bottom of the tubing receives the pump. The proximity of the pump to bottom is determined by the type of gas-anchor needed for the particular well. In the Salem field the gas-anchor used allows the pump to be located about 10 ft. from bottom; by remodelling the assembly the pump could be located on bottom.

Other details are given and illustrated. A. H. N.

579.* Schuler Unitized Repressuring Project is First in Arkansas. G. Weber. *Oil Gas J.*, 10.4.41, **39** (48), 32.—The undivided interest in the production of oil and gas and the share which each party to the agreement carries in the cost of the project are set in a tabulation of participation in the unit. The basis for participation in the unit is not producing acreage alone, as is generally the case in unitization agreements. Instead, each tract in the unit area is assigned a value in proportion to the value of all such drilling units, in the same ratio thereto as the number of barrels of oil which the drilling unit was allowed to produce each 24-hour day from the Jones sand under the allowable schedule of 1st August 1940 bears to the total daily pool allowable for the Jones sand, fixed by the Commission as a basis of said allowable schedule.

The allowable schedule for Schuler at the time designated was fixed on an acre-

pound basis. Each well's allotted acreage was multiplied by its bottom-hole pressure, either directly measured as in key wells, or interpolated from the monthly pressure map of the field. The total of all per-well acre-pound products was divided into the total daily crude allowable allotted the Jones sand, obtaining the factor, "brls./acre-pound." This in turn was applied to each well by multiplying by its acre-pound factor, and the well's daily allowable in barrels was thus determined. Hence, interest in the unit is placed on an acre-pound basis, instead of the straight acreage factor usually used in determining participation.

Primary data on the pool are presented. A. H. N.

580.* Intermittent Repressuring of Pennsylvania Oil-Sands. P. A. Dickey. *Oil Gas J.*, 10.4.41, **39** (48), 35.—One of the chief troubles in repressuring programmes is due to by-passing. The fact that intermittent injection of gas inhibits by-passing indicates that during the time when the gas is not being injected the liquids redistribute themselves in such a manner as to decrease the permeability of the by-passing channel. Therefore, when gas is again applied, more resistance is encountered. The gas is thus able to move out the oil that collected in the channel, and since a higher pressure is developed, it also affects the less permeable parts of the sand.

When gas is no longer injected, the pressure in the permeable channel will quickly drop nearly to atmospheric, and a sizable pressure drop will exist between the channel and the less permeable places. This will tend to force the oil and water towards the channel. Their presence there materially reduces the effective permeability of the channel, and they are, besides, easily forced towards the producing well. The gas entering the less permeable places will, of course, tend to force the liquids away from the channel, but it will enter more slowly than it will leave. Thus, it is more effective escaping than entering.

This action is probably more effective with natural gas than with air, because gas is more soluble in oil. Natural gas under pressure would go into solution, and on release of pressure would form bubbles in the oil as it came out. These would tend to block the pore openings and make it possible for the gas to push the oil instead of simply passing by it. As an example of the effectiveness of this action, the oil saturation of a sand was experimentally reduced 60% by the escape of gas contained in it at a pressure of 900 lb./sq. in.

If the foregoing is a correct explanation of the mechanism of intermittent air-drive, it would seem that higher pressures, and longer opportunity for the pressures to redistribute themselves, might result in more efficient recovery. Certain field experiments tend to substantiate this theory. A. H. N.

581.* Subsurface Flow Control. J. H. Rambin. *Oil Gas J.*, 17.4.41, **39** (49), 78.—The paper deals with marine localities in the Gulf Coast. During squalls, fogs, and other undesirable barging and boating conditions that are often present along the Gulf Coast, the complete control of floating marine equipment is not always possible. As an additional safety measure a positive shut-off for the well itself, to act in case any surface connections were broken off, was devised. It was necessary to obtain a shut-off for both the casing and the tubing below the ground level, since in conventional completions both have pressure and are subject to flowing oil and gas if the surface casing or tubing connections are opened.

After many experiments, some of which are described, subsurface control under all conditions was finally attained, through experiments with various types of automatic shut-off valves for the tubing. This eventually resulted in the use of an automatic valve, which depended entirely on the velocity of flow for its operation. Through the combined use, then, of the double packer and the automatic shut-of valve, it became possible to produce a well with the assurance that if for any reason the flow through the tubing exceeded a predetermined amount, the valve would immediately shut the well in until such time as it was desired to reopen it.

The principle of operation of the storm-choke assembly depends on the fact that when the fluid velocity of the oil and gas through the choke reaches a certain point, the valve automatically shuts in the well until steps are taken to release it. The releasing process is accomplished by equalizing the pressure above and below the choke, after which the valve remains open until the velocity again exceeds the limitations of the choke adjustment. Thus, the choke assembly need never be removed from the

hole unless it is desired to change its adjustment to correspond to some change in production.

The choke may be adjusted to shut off at any desired rate of flow, and experience and knowledge of each individual well, together with the quantity of production desired, are the only guides in making the adjustment. The setting depth for storm-chokes is governed by the paraffin accumulations, and it has been found to be better practice to set the choke below the normal paraffin level, which seldom exceeds 2000 ft. and is normally about 1000 ft. in this area.

Diagrams illustrate the assembly. A. H. N.

582.* **Surface-Control Equipment and its Maintenance.** R. N. Bean. *Oil Gas J.*, 17.4.41, **39** (49), 142.—The trend of development in surface-controls and flow-chokes points towards the use of a smaller size of master tubing valve and wing-valves and positive chokes that can be quickly and easily changed without leaks and galled threads. In localities where pressures are low the adjustable beans are used to flow wells the producing stratum of which does not contaminate the oil with sand or other abrasives. On high-pressure wells adjustable beans are used to arrive at an indication of size of positive choke to use; the flow is then switched back to the positive choke for permanent flowing of the well.

A review of development in chokes used for surface control is given, detailing refinements as well pressures became increasingly high. With the coming of surface-flowing pressures ranging from 2000 to 3000 lb., further refinements were made to give a better seal between the cage-nipple and the choke. Closer tolerances of the machined parts and proper selections of steel to meet choke requirements resulted in a better product. However, the present design remains substantially the same in principle as it was when first introduced, inasmuch as the chokes are still screwed into the cage-nipples. One of the chief difficulties experienced with this method in controlling high pressures has been the leaks and cutting out of the threads between cage-nipple and choke. Galled threads frequently gave operators trouble, resulting in costly replacements. To remedy this condition, numerous designs of seals, gaskets, and quick-change unions have been developed. Within the last five or six years new inventions and devices have appeared on the market to meet the need of the present high-flowing pressures that run from 4000 to 6000 lb. and in a few instances even higher.

Typical surface installations are illustrated and described. A. H. N.

583.* **East Alice Field Gas-Recycling Project placed in Operation.** N. Williams. *Oil Gas J.*, 17.4.41, **39** (49), 145.—After describing the property and its history, the recycling plant is studied. High-pressure absorption is embraced in the primary-recovery phase of the plant operation. There are three high-pressure absorbers, to which the high-pressure gas from the field-gathering system is directly charged without prior separation of any fluids. Meters and regulators ahead of the absorbers control the volume of gas and the pressure drop to each of the absorbers. The absorbers operate at pressures up to 1500 lb., as against a gas-delivery pressure to the plant of approximately 1650 lb. This entails a pressure drop of approximately 150 lb. to the absorbers. Inlet-gas temperature is approximately 100° F.

Four 600-h.p. compressors, taking suction through scrubbers from the overhead stripped gas from the three high-pressure absorbers, return the dry gas to the sand. These boost the pressure of the gas from 1500 lb. to approximately 2150 lb., which is slightly above the bottom-hole pressure of the sand. There are two input wells, both of which are located on opposite sides of the structure.

In the secondary-recovery phase of the plant operation, retention in the system of all the light, valuable constituents is effected by efficient reabsorption of volatile light fractions flashed in reduction of pressures of the rich-oil stream from the high-pressure absorbers. By careful selection of optimum temperatures and pressures for rich-oil venting, a maximum amount of gas containing a minimum amount of valuable constituents is further processed in reabsorbers.

Steam is used exclusively throughout the plant, both for processing pumps and distillation heat. Because only high-gravity material is involved, no direct-fired furnaces are needed. Facilities include a complete closed condensate system for condensing all exhaust steam. Tube sections are provided in the cooling-tower for that purpose. Boiler feed-water make-up requirements are confined to replacement of

only that steam used in distillation. Generating the steam are three 397-h.p., 250-lb. working-pressure water-tube boilers. A. H. N.

584.* Use of Extraneous Gas Prolongs Lifting Energy in Saxet Field. Anon. *Oil Gas J.*, 17.4.41, **39** (49), 172.—The high-pressure gas injected into the wells performs a double function, not only of providing the lifting medium for the oil production, but also the gas is returned to the surface to be recovered as vent gas from the separators, thus greatly augmenting the supply that would normally be produced with the oil. Under proration regulations, wells being produced under these conditions with high water yields are permitted a gas–oil ratio of 10,000 cu. ft. of gas/brl. in addition to the regular allowance of 3000 cu. ft./brl. granted flowing wells. Although dry when injected, the high-pressure gas normally picks up a certain amount of additional light-ends to be recovered in the gasoline-plant processing.

The plant has a total low-pressure absorption capacity of 70,000,000 cu. ft. of gas daily, although runs now are down to approximately 40,000,000 cu. ft. daily, due to decline of production in the oil-sands supplying the vented gas. At capacity, the plant was recovering approximately 40,000 gal. of gasoline daily, or at the rate of 0·571 gal./1000 cu. ft. of gas. With present runs, approximately 25,000 gal. (0·625 gal./1000 cu. ft.) are being produced.

Originally, a capacity of only 20,000,000 cu. ft. of gas daily was provided. Then the plant was designed to handle only the vent-gas produced with the oil from the 5800-ft. sand, which at that time was in its early stages of development. With that capacity the plant produced approximately 10,000 gal. ($\frac{1}{2}$ gal./1000 cu. ft.) daily.

Other details of the plant are given. A. H. N.

585.* Drilling Cost Primary Factor in Secondary Recovery. F. B. Taylor. *Oil Wkly*, 24.3.41, **101** (3), 14–16.—Certain budget factors have as much bearing on the financial success of secondary oil-recovery projects as probable production and revenue returns, and should be carefully considered by operators planning such operations. With narrow profit margins it is not enough to accept extremely rough estimates of costs and plot these against indicated revenues. Mid-Continent experience during the past several years, a period of vastly increased application of secondary-recovery programmes, has shown the largest single expense item involved is the cost of drilling new wells. Yet greater error has been made in calculating this figure than in any other factor.

Depth variations from 100 ft. to 1000 ft. do not effect a material difference in drilling costs. A well that can be drilled to 650 ft. for 80 cents/ft. cannot be drilled to 300 ft. on the same location for much less than 70 cents/ft. At about 900 ft. the per-foot cost does begin to indicate an increase, but to 1000 ft. this increase is not critical. Contractors and operators developing recovery projects point out that actual drilling time is more or less proportional to depth, but moving, shooting, cementing, and cleaning-out time is independent of depth.

Taking three specific areas, costs have been determined on a per-foot basis in Northeast Oklahoma as averaging 61 cents on one project and 76 cents on another, with the latter figure including some minor equipment expense. In Kansas projects are being drilled from 85 to 92$\frac{1}{2}$ cents/ft. to a depth of 800 ft. In this area, in addition to a slight increase in the per-foot cost as a result of increased depth, there is more lime in the section, and consequently hole is a little slower to make. In North Texas, where conditions probably vary more than in any other comparable area, shallow drilling costs range from 55 cents to as high as 95 cents/ft.

Analyses of drilling costs on other projects have shown per-foot rates as low as 44 cents. The method of keeping cost accounts has much to do with per-well expense figures, and variations in formation result in minor changes from well to well. If equipment is added to the drilling cost, it should be part of the drilling function, not part of production equipment cost. A. H. N.

586.* Gas-Well Acidizing. G. L. Leach. *Oil Wkly*, 24.3.41, **101** (3), 17–20. *Paper presented before American Petroleum Institute.*—Special difficulties are encountered in the acidizing of Texas Panhandle wells because instead of pure limestone, dolomite, and dolomitic limestone, mixtures are generally encountered. These respond in an entirely different manner from regular acid. Being comprised of complex magnesium–

calcium carbonates with varying amounts of silicates, sand, granite, chert, shale, iron, and alumina, and frequently with large quantities of gypsum, anhydrite, and selenite, they react much more slowly. Many iron and aluminium compounds will dissolve in hydrochloric acid, but as the acidity of the treating solution decreases these compounds reprecipitate out of solution as highly flocculent, gelatinous hydroxides. Such precipitates occupy at least forty times the space of the original oxides and may contribute to the damming or plugging of the drainage pores.

Laboratory and field research has resulted in new acidizing methods which overcome many of the difficulties encountered. Some of the more important improvements involving addition agents for acid having particular application to Panhandle acidizing are: (1) intensifier to increase the rate of reaction of acid on slowly soluble dolomites; (2) retarding agents to slow down the rate of reaction and allow for further penetration away from the well-bore; (3) low surface tension and wetting agents to decrease the resistance to flow of both fresh acid and spent acid solution; (4) stabilizers to reduce secondary precipitation of iron and aluminium; (5) inhibitors to eliminate corrosion of the casing and tubing.

Except in unusual conditions, gas-well treatments are made down the casing. As a first step, the well is blown to the air until clean of fluid and shut in. After suitable well-head connections have been made and the hole measured up to check that it is open to bottom, the first stage is ready to begin. Usually in the first stage 1000 gals. of acid are pumped in the casing and the compressor is immediately started. From the commencement of the treatment until its completion casing pressures are recorded at frequent intervals. Fluid levels as determined with a float on the measuring line are included in the records.

Displacement of the fluid is continued until first, a pressure break is experienced; and second, the fluid level, as measured with the float, remains constant. This indicates that gas is entering the formation at that point, and that no more fluid can be displaced from the well-bore.

After 1 hour or less, depending on the type of acid and auxiliary chemicals used and the character of the formation, the well is opened and allowed to blow to the air until clean of fluid. The first stage serves mainly to clean the pore-space in the immediate vicinity of the hole preparatory to the treatment proper. This treatment is usually a repetition of the same procedure but utilizing larger quantities of acid.

Other details and methods are described. A. H. N.

587.* Economics of Chemical Treating Crude Oil Emulsions. C. Hetherington, L. Battle, P. Haskett, and R. L. Huntington. *Oil Wkly*, 24.3.41, **101** (3), 33–34.—An item of considerable expense on some leases is that of treating water-cut oil production. When using chemical or soap treatment for this purpose, the desired improvement in relationship between operating expenditures and income may be accomplished by balancing chemical or soap cost against vapour losses caused by high treating temperatures. In this article the economics of a specific case are analysed, both graphically and mathematically, in order to determine the optimum operating conditions. It is thought that this example may show producers how costs on this phase may be lowered. The solutions use a balance between heating cost, soap cost, and loss in price of oil due to evaporation under high temperatures. A. H. N.

588.* Automatic Crude-Treating Plant Operates Continuously Without Attendance. Anon. *Oil Wkly*, 14.4.41, **101** (6), 20–22.—The plant, besides auxiliary equipment, contains: two electrically operated dehydrating vessels, for removing the water from the oil; two oil and gas separators, one of which removes the free gas and the other the vapours produced by heating of the oil; a double setting of oil heaters and coolers, one section operating on a cold-and-hot oil exchange and the other on an oil-and-steam exchange; one common oil-field-type boiler equipped to operate at a maximum pressure of 15 lb.; two stock-tanks, one to receive the oil from the treater while the other is being emptied into the pipe-line.

Water separated from the fluid is re-circulated by a small motor-driven centrifugal pump. This holds the emulsion-cake layer, which invariably lies between the water and the partly treated oil, to a minimum, and permits the electrodes in the electrified zone to remain clean. It has been found that re-circulation of the hot water through

the vessel helps to provide effective treating. The quantity of water separated averages 7½ brls./hr.

The steam line between the exchanger and boiler dome runs overhead on an "A" frame fabricated from pipe. In this line, near the exchanger inlets, is a control valve that regulates the volume of steam passed from the boiler to the heaters, thus providing a means of having a constant predetermined temperature. This steam-control valve is actuated by an adjustable recorder-controller, located on a small panel at the control end of the steam exchangers. The steam-control valve is protected from the weather by a hooded cover, in which is a receptacle for unused charts.

Details of the plant are illustrated by photographs and diagrams and discussed at some length. A. H. N.

589.* Hydraulic Pumps used to Produce Prorated Wells. J. N. Miles. *Oil Wkly*, 21.4.41, **101** (7), 11–14.—In order to obtain the most attractive investment, operating, and maintenance picture possible, the producing equipment installed at the well must be an economical investment from the first cost to and through a long life of efficient operation, with low supervision and operating expense.

Some of the requirements pumping equipment must meet in order to satisfy the above financial and operating problems are: (1) Low investment cost. (2) Low operating expense. (3) Capacity to produce 15 brls./hr. over short periods for the determination of potentials. (4) Capable of producing at low rates for slow withdrawal purposes. (5) Capable of being used on as many types of wells as possible. (6) High operating efficiency at all rates of production. (7) Simplicity of operation to permit a minimum of direct labour and supervision charges. To meet these requirements twenty-five hydraulic pumps are used, drawing power from five central power-plants.

One central power-plant furnishes power-oil to actuate eight 2½-in. hydraulic bottom-hole pumps, each having maximum production capacity of 500 brls./day. The other four plants do not have a complete number of wells connected. They are equipped with 5000 lb. maximum pressure, 400-brls./day-capacity triplex pumps, being driven by 217-cu.-in. multi-cylinder gas-engines and one by a 202-cu.-in. multi-cylinder gas-engine.

It was first thought necessary to install the 2½-in. production unit in order to have a pump capable of producing 15 brls./hr. during the modified potential tests now used in Kansas, but by the use of higher operating pressure it was found that the 2-in. production unit was capable of producing 15 or more brls./hr. for the short period necessary to establish a potential test. This reduction in size of pump allowed a reduction in tubing sizes and an overall decrease in per-well costs.

All bottom-hole hydraulic pumps connected to the small high-pressure triplex power units are of the 2-in. size. It was necessary to use a high-pressure surface pump on the last four installations in order to pump 15 brls./hr. with the 2-in. bottom-hole pumps which are normally rated at 11·25 brls./hr.

Costs are discussed and found favourable.

Methods of paraffin removal are outlined. A study of the removal and prevention of paraffin accumulation is being continued, and more information should be available at a later date.

The hydraulic pump being used on these leases can operate in wells with a fluid-lift of 6000 ft. by the application of high pressure to the power oil, or it will operate in wells with a shallow lift. This adaptability to wells of wide variation in depth and its flexibility in production capacity allow this one-size pump to be used in many different areas. A. H. N.

590.* Mud Removal During Completion Increases Well Initial. Anon. *Oil Wkly*, 21.4.41, **101** (7), 15.—A review is given of difficulties which finally resulted in the development of the relatively new completion technique, which provides improved washing methods for cleaning the walls of the hole. The new practice features the principle that mud removal from the wall of the hole is necessary, and accomplishes this by a combination of abrasion and circulation.

The procedure, used for both new completions and work-overs at Wilmington in twenty-five cases, has been to mount wall-cleaning guides at spaced intervals on the

outside of the liner or screen throughout its entire length. These wall-cleaning guides are collars on which oil-tempered spring-steel wires or abrading members are mounted.

Circulation is confined to the space between the liner or screen and the wall by installing a wash-pipe assembly. The entire assembly of perforated or gravel-packed liner, together with the washing unit, is run in on the drill-pipe or tubing.

After reaching bottom, circulation is first established and continued as the liner is alternately raised and lowered in increasing amounts until the travel is slightly greater than the spacing between the wall-cleaning guides. Repeated movements abrade the wall, and circulation with oil or clear water removes the mud and bit cuttings which make up the filter-cake formed during drilling operations.

Return circulation from bottom shows large amounts of this material removed from the walls by the scratching action of the spring-steel wires. The character, particle size, and amount removed explain the satisfactory completions obtained by the procedure.

A report on a work-over job in the extreme south-western corner of the Wilmington field—an area which yields heavy oil—shows an increase in production from 18 brls. to 145 brls. daily through gravel-packed liner. Farther to the north-west a work-over job resulted in a 200-brl. well, in contrast with the well's original output of 125 brls. daily a year earlier. A. H. N.

591.* Repressuring Profitable in Kansas Shoestring Sands. L. L. McWilliams. *Oil Wkly*, 21.4.41. **101** (7), 17–20. *Paper Presented before American Petroleum Institute.*—The oil in the pool is a dark-green colour, of paraffinic base, and sweet, and quite desirable at refineries, having about a 35% gasoline cut and good lubricating qualities. The viscosity is believed to be about 5 centipoises, which is considered excellent for repressure purposes. The original gravity was about 40–42° A.P.I. It has been reported in some instances, however, where repressuring has raised the gravity, that little use is made of such information. These pools were developed before the advent of bottom-hole sampling, consequently it is not known whether the oil was saturated at the original bottom-hole pressure.

Although the spacing patterns are not consistent, the average ratio of input to producing wells will vary from a minimum of 1 to 3 and a maximum of 1 to 7.

The media for injection into the input wells is air, recycle, and purchased gas; however, gas is the more desirable and the most widely used. The policy of the operators varies as to the media injected. The majority of operators feel that the purchase of outside gas to supplement the recycle gas is justified. In two projects the operator supplements the recycle gas with as much as 25% air and reports no apparent detrimental effects. There are several sources of purchased gas in these areas; however, most of the pools are supplied by one major gas company which has lines in the area.

The injection pressures and volumes vary considerably in individual pools. On projects where data are available the injection pressures are observed to vary from 20 to 550 lb. The higher pressures are noted to be in the poorer pools or in the poorer parts of the individual pools. The input volumes are observed to vary from 10 to 300 M.C.F./well/day, and the average volume/well is observed to vary greatly between some pools. The variance in input volumes for the individual pools is primarily attributed to the difference in opinion of the operators.

A very important development during the last few years has been the unitization of properties within the individual pools. The operators are usually quite agreeable to unitizing their properties and on some basis such as past production, producing wells, and current oil production. Unitization has many advantages from the standpoint of operation and repressuring. Naturally, with unitized operation, well-operating costs can be reduced. Unitization offers the cheapest repressure costs to the operators, in addition to the most flexible programme for input-well spacing and input volumes. In several of the major projects it is doubtful if widespread repressuring could have been effected without unitization.

An interesting development which is increasing in application is the injection of small volumes of water together with the input gas. The essential idea is to reduce the movement of gas through the more permeable streaks of sand. Although this practice is still in the experimental stage, it is known that in one instance the gas/oil

ratio of wells off-setting the input wells was reduced and in another instance the oil production on off-set producing wells is reported as increased. A. H. N.

592.* Breaking Oil-Water Emulsions in the Storm Field, Illinois. J. C. Albright. *Petrol. Engr*, April 1941, **12** (7), 25.—Because of the peculiarity of the emulsion, settling at atmospheric temperature was not successful, and it was observed that the cut oil should be heated to a high temperature, and chemicals added to obtain a satisfactory break. In some instances heating with the addition of chemicals was not sufficient to reduce the oil to pipe-line grade on a once-through pass from the separators to stock tanks, requiring re-circulation by means of pumps. On most leases, however, the once-through application of heat and chemicals reduces the cut oil to a satisfactory pipe-line grade.

The type of equipment most commonly employed at Storms for treating emulsified oil consists of the usual stock-tank battery, a treating-tank with a down-comer or flume, which places the heated oil and emulsion on the floor of the vessel, so that when the oil being treated begins to rise it is forced through a body of warm water to the outlet at the top. Oil then passes to a second tank for siphoning-off the water released at this point.

The wells are usually single-trapped to separate the oil from the gas, with the flow-line running to the battery and water-separator. But to heat this oil, and successfully treat it, there is placed in the flow-line a tubular-type furnace with automatic equipment for maintaining the required conditions while the well, or wells, flow through the apparatus. A. H. N.

593.* Machine-Design Problems Encountered in the Petroleum Industry. M. L. Begeman and V. L. Doughtie, *Petrol. Engr*, April 1941, **12** (7), 29–32.—All the following factors should be at least considered in a properly designed member: strength, rigidity, fatigue, corrosion, wear-resisting qualities, safe operation, and economical operation. Some thought should be given to general appearance, but in equipment of this type it is not of primary importance. Accessibility, ease of repair, and lubrication are to be expected in any good design.

One of the most difficult items to determine in machine design is the allowable or design stress. This stress is defined as the ultimate strength of a material divided by the factor of safety. Usually the ultimate tensile stress and yield-point in tension are known, but information regarding shear, compression, and endurance limits is frequently not available.

To determine the factor of safety, first the type of loading—*i.e.*, whether the load is static or dynamic—should be ascertained. With static loads the real carrying strength of a material is the yield-point. Under such conditions the apparent factor of safety is the product of two factors, one to reduce the strength of the material from the ultimate to the yield-point, and the other—called the real factor of safety—is to care for emergencies and unknowns. The first factor is from 1½ to 2, and the second is 1½ to 2 for steel, 2 to 3 for cast iron, and 3 to 4 for wood.

The real carrying strength for live loads depends not on the yield-point, but on the endurance limit of the material. If the endurance limit for the type of load applied is known, therefore, the design stress would be determined by dividing the endurance limit by a real factor of safety. The endurance limit will depend on the type of loading—*i.e.*, whether the load is reversed in one direction or completely reversed—on the number of repetitions of stress, and whether gradually applied or impact. Thus the apparent factor of safety is the product of four factors which are defined and discussed.

A general study is made of designing bearings and bolts and of material selection for different jobs. A. H. N.

594.* Gas-Lift in Combination with Other Production Methods. S. F. Shaw. *Petrol. Engr*, April 1941, **12** (7), 56.—Three types of combination gas-lift are discussed: (1) gas-lift with beam pump or other plunger-pump equipment; (2) gas-lift with electrical submersible centrifugal pump; (3) gas-lift with hydraulic pump.

A typical example of the first type is the Jackson pump, which was tried in a few wells in the Oklahoma City field, and gave some promise of success, and in a few wells seemed to operate fairly successfully for a short period. This combination method

consisted of a plunger pump run on a tubing string to the bottom of the well. A packer was run on the tubing to seal-off the annular space between the tubing and the casing, at a short distance above the pump. Compressed gas was introduced through the casing and used to operate the pump. The oil lifted by the pump, together with the exhaust gas that had been employed to drive the pump, were lifted to the surface through the gas-lift column by means of the gas-lift action of the expanding gas.

The centrifugal-pump combination method operated to best advantage in wells that had been completed with the casings of larger diameters, which in this field were as large as 9⅝-in. O.D., and in many of these wells with this larger diameter of casing the tubing was of 3-in. diameter, thus reducing the friction loss due to the passage of the gas from the surface to the point where the tubing is perforated above the packer.

The oil picked up by the centrifugal pump was lifted to a point above the packer where the tubing was perforated, thus allowing the oil to pass into the casing at that point. The compressed gas was pumped down the tubing to these perforations and passed out into the casing, mixing with the oil and lifting it to the surface.

A few installations of hydraulic pumps in combination with gas-lift have been made in the Oklahoma City field. In this method the hydraulic pump is run on the lower end of a string of 5-in. casing, with a packer set at about 500 ft. above the pump, and the oil passing through the pump was lifted through this larger pipe to perforations in the pipe above the packer, and then passed into the casing. The oil-producing pump is driven by power-oil pumped by a triplex pump on the surface through a string of 1½-in. tubing, which is run inside the 3-in. tubing. The gas employed for lifting the oil is admitted at the surface to the annular space between the 3-in. and 1½-in. tubing strings, passes downward to the power end of the pump, operates the pump, then exhausts into the flow of oil that is pumped from the well, and passes into the casing above the packer. From the perforations above the packer the oil is lifted by the gas that passes down through the annular space.

All three methods are illustrated, and certain difficulties encountered in their use and other characteristics are detailed. A. H. N.

595.* Acidizing to Remove Drilling-Mud and to Clean-up Sandstone Formations. S. C. Morian. *Petrol. Engr*, April 1941, **12** (7), 67.—To deal with the problem of removing mud-sheaths, "mud acid" was developed. Mud acid is composed of chemicals capable of dissolving and disintegrating practically all types of bentonitic clays such as are used in drilling-muds, and also many of the clay-like compounds that are a part of the reservoir rock itself. It also contains surface-tension lowering and wetting agents that aid in the removal of water that may have entered the formation from the drilling-mud when a well was drilled-in. The surface tension-lowering agents chosen specifically for mud acid permit the treating solution to be squeezed into the formation at lower pressures, give better penetration into the minute pore spaces, and more easily effect removal of the reaction products from the formation. Wetting agents and emulsion preventers are selected for each treatment according to the type of crude oil produced from the particular well being treated. A table and a graph show that mud acid will dissolve ½ lb. of a typical bentonitic mud, as compared with practically none in 15% hydrochloric acid.

The selection of a well, pool, or area producing from a sand formation where mud acid might be used beneficially should be guided largely by: (1) core analysis; (2) initial completion methods; and (3) decline curve behaviour.

Wells of the following types are suitable subjects for mud-acid treatments: (1) Any well the core examination of which shows 10–20% or more bentonite. (2) Any well surrounded by better producers in the same formation. (3) Any well that has been worked-over using drilling-mud or water in the operation. (4) Any well that has been completed recently. (5) Any well making water and oil in certain quantities or ratios. (6) Any well where strainer arrangement is set.

For recycling operations in gas-condensate fields, the injection pressures necessary in order that large volumes of gas may be injected into the intake well have in many cases been in excess of 3000 lb. The horse-power requirements in compressing gas to these high pressures is a very serious problem, so that any method of reducing the high input pressures or of increasing the input volume at constant pressure results in a tremendous saving in horse-power and consequently in operating expense. Mud acid has been used to increase the permeability and porosity of the area near the well-bore

of gas-injection wells, and the results have been outstanding in the degree of success experienced in reducing the input pressures and increasing the capacity of the key wells. A. H. N.

596. Patents on Production. J. H. Howard. U.S.P. 2,234,493, 11.3.41. Appl. 19.7.38. Well-completing device consisting of a hollow tool-joint having a screw-threaded socket at its upper end and a reduced intermediate portion provided with coarse screw-threads and a wrench pin on the lower end of the joint.

V. B. Zacher. U.S.P. 2,234,790, 11.3.41. Appl. 13.2.39. Mud-wall disintegrator consisting of a weak acid and a salt which, on reaction, yield products which disintegrate the mud-sheath.

F. H. Ohland. U.S.P. 2,234,977, 18.3.41. Appl. 19.2.38. Sand-pump which induces a surge of liquid into the cylinder.

R. T. Cloud. U.S.P. 2,235,064, 18.3.41. Appl. 16.7.38. Determination of densities of fluids in wells by means of a weight suspended on a spring.

C. A. Shope. U.S.P. 2,235,265, 18.3.41. Appl. 5.6.39. Sucker-rod rack with a ratchet wheel.

F. C. Koch. U.S.P. 2,235,639, 18.3.41. Appl. 10.5.38. Resolution of oil and water emulsions.

I. X. Calhoun. U.S.P. 2,237,303, 8.4.41. Appl. 1.6.38. Pumping mechanism for oil-wells of the reciprocating type, fitted with pneumatic counterbalance between the walking-beam and the sucker-rod connection and utilizing the compressibility of air.

C. F. Prutton. U.S.P. 2,237,313, 8.4.41. Appl. 24. 12. 38. Method of treating well-bore walls with a liquid sealing mixture to seal the fine pores and then forming flow channels by means of explosives.

E. K. Burgher. U.S.P. 2,237,408, 8.4.41. Appl. 18.11.38. Well-pumping apparatus with a lift-tube and a piston which is stationary while the well-fluid is accumulating above it, and is moving when fluid under pressure acts upon it.

H. C. Block. U.S.P. 2,237,544, 8.4.41. Appl. 21.5.38. Collapsing tool seal for a well-bottom assembly.

C. C. Myracle. U.S.P. 2,237,612, 8.4.41. Appl. 8.8.39. Apparatus for washing perforations.

H. R. Mark. U.S.P. 2,237,680, 8.4.41. Appl. 13.12.37. Well cap.

D. W. Hoferer. U.S.P. 2,237,703, 8.4.41. Appl. 24.5.38. Well-pump lock for suspending a well-pump from a tubing-shoe having an internal seat and an opening of uniform diameter.

J. C. Donaldson. U.S.P. 2,237,863, 8.4.41. Appl. 23.2.40. Combined guide and scraper designed to encircle a well-string.

S. L. McCumber and F. Buck. U.S.P. 2,238,423, 15.4.41. Appl. 30.9.30. Tubing-rack in combination with a derrick structure.

D. H. Crepeau. U.S.P. 2,238,462, 15.4.41. Appl. 1.5.40. Pipe-joint.

E. H. McClease. U.S.P. 2,238,533, 15.4.41. Appl. 17.12.38. Tubing attached reinforcing trapping strainer adapted for lowering and pulling in a well and for occasional reciprocation to break up sand-bridges without pulling the well-tubing or assembly when attached.

J. C. Woodhouse. U.S.P. 2,238,671, 15.4.41. Appl. 9.2.40. Method of treating wells to increase production by introducing into the well a readily hydrolyzable substance.

B. McCollum. U.S.P. 2,238,701, 15.4.41. Appl. 9.1.39. Method of recovering oil from oil- and gas-bearing sands by returning the gas from one well into another.
A. H. N.

Transport and Storage.

597.* Constancy of Application is Important Factor in Cathodic Protection. N. Williams. *Oil Gas J.*, 5.12.40, **39** (30), 53.—Results of work carried out by Houston Pipe-line Co. over several years on the application of cathodic protection for its lines have led to the conclusion that one of the most important factors is the constancy with which the protective potential is maintained.

It has been established that with the cessation of the electric charge producing the cathodic protection the potential built up gradually dissipates. Research has indicated that corrosion of iron ceases when the negative potential built up is below −0·2853, and the problem of maintaining a negative charge below this point has been given particular consideration.

Where purchased power is not available, wind-driven generators are provided, and these are entirely dependent on wind conditions. To take care of the periods when the wind-charger is not working, the Company has installed two wind-chargers, one charging direct to the line and the other charging batteries. As soon as these chargers cease to function the storage battery is automatically cut in.

The discharge rate of the battery is only about one-quarter the average current supplied by the larger direct wind-charger, but it has been found adequate to hold the negative potential of the line over almost any period the wind-chargers might ordinarily be out of action.
D. L. S.

598.* Tank Contents Nomograph. D. S. Davis. *Industr. Engng Chem.*, 1940, **32** (10), 1412.—A nomograph is given which enables the volume of the contents of a horizontal cylindrical tank to be computed from the depth expressed as a percentage of the diameter.
J. W. H.

599.* Economic Pipe-size in the Transportation of Viscous and Nonviscous Fluids. B. R. Sarcket and A. P. Colburn. *Industr. Engng Chem.*, 1940, **32** (9), 1249.—A nomograph is given which enables the economic pipe-size at which pipe and pumping costs are at a minimum to be determined from a knowledge of the density, viscosity, and flow-rate.
J. W. H.

Crude Petroleum.

600.* Cracking Eastern Venezuelan Crude Oil. G. B. Zimmerman, D. Read, and G. Egloff. *Oil Gas J.*, 26.12.40, **39** (33), 141.—An examination has been made of Temblador crude from Eastern Venezuela, showing yields on distillation to fuel and cracking results on a Dubbs pilot plant of topped and reduced crude. Temblador crude is a heavy asphaltic oil with specific gravity 0·920, sulphur 0·90%, cold test $< -35°$ F., and viscosity S.U. at 100° F. of 191 secs. On laboratory distillation it yields (by vol.) 12·1% gasoline (23% to 100, E.Pt. 204° C., O.N. 65·5), 17·7% of kerosine, and 70% of residue (viscosity 134 secs. S.F. at 122° F.). The topped crude after removal of gasoline has a viscosity of 63·2 S.U. at 210° F. On cracking, the (*a*) reduced and (*b*) topped crudes yield respectively (by vol.) (*a*) 30·3% of gasoline (40% to 100° C. 204° C. E.Pt. O.N. 74) and (*b*) 32·4% of gasoline (of similar characteristics) and (*a*) 65·5% of residue (viscosity 224 S.F. at 122° F.) and (*b*) 63·0% of residue (viscosity 446 S.F. at 122° F.).

The straight-run gasoline is highly aromatic, and suitable for the production of aviation base-stock. The cracked gasoline contains 0·37% sulphur and is very sour, but is rendered satisfactory by vapour-phase clay treatment or acid-washing. The cracked gases (analysis given) can be polymerized to yield 2·4% of polymer gasoline.
C. L. G.

Cracking.

601.* Economic Factors in Catalytic Cracking. J. S. Carey and H. W. Ortendahl. *Oil Gas J.*, 17.10.40, **39** (23), 55.—Thermal cracking is now a well-established process, but the advent of catalytic cracking has brought additional variables and concepts which have to be considered.

The chief of these are :—

1. Catalyst activity.
2. Space rate.
3. On-stream operating conditions (temperature, pressure, etc.).
4. Regeneration conditions (amount of carbon to be removed, heat removal, and the related temperature control).

In this paper catalyst activity is defined by results obtained on a standard charging stock under standard conditions when operating a standardized type of laboratory pilot plant. It is essential that the catalyst be of a type that is easily regenerated.

With a fixed catalyst activity the space rate becomes the next prime factor. Thus for a given stock it is possible to vary the yield of once-through gasoline over a wide range. In this way a refiner may operate his plant to give him an amount of catalytic gas oil to use on his thermal cracking-plant.

The operation of a catalytic plant with a typical feed-stock is discussed, and yields, working costs, etc., are fully dealt with.

The authors conclude by stating their belief that the Houdry process has pointed the way to a new concept for the economic production of high-octane motor fuel.

D. L. S.

602. Patents on Cracking. Standard Oil Development Co. E.P. 534,856, 20.3.41. Appl. 15.9.39. Production of valuable low-boiling products, suitable for gasoline, from heavier hydrocarbons. The oil, which must be capable of being completely vaporized under cracking conditions, is forced through a pipe-coil while under sub-atmospheric pressure of at least 200 lb. per sq. in. and heated during its flow therethrough to 800–850° F., so as to cause complete vaporization. After vaporization a solid natural or synthetic siliceous cracking catalyst is added and contact maintained between the oil vapour and the catalyst for sufficiently long to effect substantial conversion of the oil into gasoline.

E. A. Ocon. E.P. 534,970, 25.3.41. Appl. 22.6.39. Production of motor fuel by cracking petroleum hydrocarbons, mixing the cracked product with highly oxidized unsaturated aliphatic hydrocarbons and reducing gases. Subsequently vapours boiling mainly below the gasoline range are separated out, together with the gases, and are caused to react in the presence of an alkaline metal base and a metal oxide dehydration catalyst.

G. W. Johnson. E.P. 535,049, 27.3.41. Appl. 8.9.38. Process for cracking hydrocarbon oils, in particular heavy benzine or middle oils. The initial material is passed in vapour phase over catalysts rigidly arranged. As catalysts natural or synthetic aluminium silicates may be used, and, if desired, these may have been treated with acids—*e.g.*, hydrofluoric acid. Alternatively, alumina or active carbon can be employed, or one or other of these substances in conjunction with the oxides of chromium, molybdenum, or zinc.

J. G. Alther. U.S.P. 2,236,083, 25.3.41. Appl. 5.5.39. Process for the catalytic conversion of hydrocarbon oils. Relatively light and heavy oils are subjected to independently controlled catalytic cracking in separate cracking zones. The resultant heated products are thereafter discharged from both zones into a reaction zone and subjected to the same non-catalytic cracking. Vapours are then removed, fractionated to form relatively light and heavy reflux condensates, and these supplied respectively to the light-oil cracking zone and the heavy-oil cracking zone. Finally the fractionated vapours are condensed.

H. B. M.

Hydrogenation.

603.* Rôle of the Catalyst. Homer Adkins. *Industr. Engng Chem.*, 1940, **32** (9), 1189.—In this article the author discusses in a general manner the requirements of catalysts in organic reactions, with particular reference to hydrogenation.

A catalyst is defined as a substance that accelerates or causes a reaction to take place. The characteristics of an effective catalyst are discussed, and it is stated that such a catalyst for hydrogenation must combine, in addition to maintaining its active state under reaction conditions, the following properties :

1. It must adsorb and activate hydrogen.
2. It must adsorb and activate the hydrogen acceptor.
3. It must hold them in the proper ratio and space relationship.
4. It must desorb the desired product.

The remaining topics discussed are : competitive reactions, effect of hydrogen pressure, active centres, selectivity of the catalyst, chemical structure of the reactants, equilibria and chemical rates, and catalyst poisoning. H. E. T.

604.* Catalysts from Alloys. M. Raney. *Industr. Engng Chem.*, 1940, **32** (9), 1199.—Efficient nickel catalysts may readily be prepared from alloys of metals. The simplest form of alloy consists of two components, one being the catalytic material and the other a substance easily soluble in a solvent which does not attack the catalytic material. Some alloys of this type consist of mixtures of nickel and aluminium. The actual composition of the alloy in the most useful range is complex, and is probably made up of several combinations of nickel and aluminium, with perhaps traces of the free metals. Many alloys within the practical working range produce equally efficient catalysts. Some of the most useful proportions of nickel and aluminium for the alloy are : 50% Ni–50% Al, 42 Ni–58 Al, and 30 Ni–70 Al. These percentages correspond approximately to the nickel–aluminium compositions $NiAl_3$, $NiAl_3$, and $NiAl_2$, respectively. The latest studies of the nickel–aluminium system indicate the existence of Ni_2Al, NiAl, and Ni_2Al_3, but not of $NiAl_2$ or $NiAl_3$. Catalyst alloys of Ni–Al have little if any other uses. A 50–50 nickel–aluminium alloy, employed for making a finely divided nickel catalyst, has few of the physical properties of either nickel or aluminium. It is not ductile or malleable, has little tensile or compressive strength, and, in common with aluminium, is non-magnetic. It has a high melting point, cools rapidly, and is difficult to cast. It is friable and easily crumbled and reduced to a fine powder.

The equipment required for preparing nickel catalysts from nickel–aluminium alloys is of the simplest type, consisting in general of a mixing and drying tank.

The catalytic properties of nickel catalysts prepared from alloys are different in many respects from those of nickel catalysts prepared by other methods. A graph is given showing that cotton-seed oil hydrogenated with : (*a*) 0·5% Raney nickel and (*b*) 0·5% reduced nickel, gave substantially the same product, indicating that catalysts of widely differing physical properties have practically equal hydrogenating characteristics. The Raney nickel catalyst was about 167 mesh and the reduced nickel about 325 mesh. The Raney catalyst was pyrophoric, whilst the reduced nickel was not. The maximum temperature employed in hydrogenating the cotton-seed oil was 385–390° F. under a pressure of 15 lb. per sq. in. H. E. T.

605.* Hydrogenation of Petroleum. E. V. Murphree, C. L. Brown, and E. J. Gohr. *Industr. Engng Chem.*, 1940, **32** (9), 1203.—In the petroleum industry the hydrogenation process has been adapted to the following processes :—

1. High-octane-number aviation gasoline production from kerosine and gas-oil fractions.
2. Motor gasoline production from gas oils.
3. Aviation blending agent production by saturation of branched-chain polymers.
4. Production of high-grade diesel fuels from low-quality gas oils.
5. Production of water-white paraffinic kerosines from inferior-quality distillates.

6. Production of high-viscosity-index lubricating oils from poor-quality lubricating distillates.

7. Refining (or "hydrofining") of gasolines to low sulphur content and high stability.

8. Conversion of asphaltic crudes and refinery residues into lower-boiling gas ores of increased paraffinity.

9. Preparation of low-aniline-point high-solvency naphthas.

10. Preparation of high-flash–high-octane-number safety fuels.

The theoretical background of these various applications of hydrogenation is briefly discussed, and the commercial application of the more important processes are given in some detail. The economics of such processes are discussed. H. E. T.

606. Patent on Hydrogenation. Standard Oil Development Co. E.P. 535,091, 28.3.41. Appl. 19.9.39. Improved methods of dehydrogenating hydrocarbons, particularly commercial naphthas and other stocks boiling within or somewhat above the gasoline range. The catalysts employed are complex bodies containing nickel borate. H. B. M.

Polymerization.

607. Patents on Polymerization and Alkylation. Standard Oil Development Co. E.P. 534,456, 7.3.41. Appl. 2.6.39. Improvement in the production of relatively low-boiling saturated aliphatic hydrocarbons useful in the preparation of gasolines. A mono-olefin containing not more than 5 carbon atoms in the molecule is reacted with more than the molecular equivalent of an *iso*paraffin boiling below or within the gasoline range in the presence of a double salt complex catalyst. The reactants are maintained in contact with the catalyst for a sufficiently long period of time for saturated liquid hydrocarbons boiling within the gasoline range to be produced.

J. G. Fife. E.P. 534,492, 7.3.41. Appl. 28.9.39. Production of liquid-saturated benzine hydrocarbons. *iso*Paraffins are alkylated by reaction with alkenes in the presence of catalysts comprising strong inorganic polybasic acids and boron halides. The reaction mixture contains at least one molecule of *iso*paraffin per molecule of olefin.

C. Arnold. E.P. 534,539, 10.3.41. Appl. 8.9.39. Process of destructive alkylation for the production of motor fuels. Normally liquid hydrocarbons and normally gaseous hydrocarbons substantially free from hydrogen and methane are passed through a reaction zone at a temperature between 950° and 1050° F. and at a pressure between 500 and 1000 lb. per square inch in contact with a catalyst containing chromic oxide. Thereafter the reaction products are removed, and liquid hydrocarbon fractions suitable for use as motor fuel separated out.

N.V. de Bataafsche Petroleum Maatschappij. E.P. 534,876, 20.3.41. Appl. 9.11.39. Production of liquid-saturated hydrocarbons having high anti-knock values and being suitable for use in aero-engines, by thoroughly contacting neutral sulphuric acid alkyl esters in the presence of sulphuric acid of at least 85% concentration with *iso*alkanes.

Anglo-Iranian Oil Co., E.P. 535,062, 27.3.41. Appl. 21.9.39. Use of inexpensive materials as phosphoric acid catalysts in the polymerization of olefines, hydration of olefines and for use in other known reactions in which such catalysts are indicated. The catalysts consist of homogeneous mixtures of compounds of phosphoric acid, calcium and copper in a neutral, dry, porous and consolidated state.

Standard Oil Development Co. E.P. 535,064, 27.3.41. Appl. 21.9.39. Improvements in the alkylation of hydrocarbons and in the production of saturated hydrocarbons boiling within the motor-fuel range. A mixture containing at least one *iso*paraffin boiling below the final boiling point of the desired motor fuel is reacted with at least one member of the group consisting of normally gaseous mono-olefins or low-molecular-weight polymers or co-polymers thereof in the presence of concentrated sulphuric acid containing an oxide of the fifth group of the periodic system.

. N.V. de Bataafsche Petroleum Maatschippij. E.P. 535,142, 31.3.41. Appl. 27.11.39. Production of liquid saturated hydrocarbons by treating butanes and/or pentanes with hydrocarbons of aliphatic character, obtained by the polymerization of alkenes. The treatment is carried out in the presence of aluminium halides and of substances having an activating effect—*e.g.*, hydrogen chloride, alkyl chlorides.

N.V. de Bataafsche Petroleum Maatschappij. E.P. 535,145, 31.3.41. Appl. 19.1.40. Production of alkyl halides from alkenes and hydrogen halide in the presence of catalysts. A solution of an acid-acting metal or boron halide which is known to be a catalyst for the addition of hydrogen halide to the double bond of an alkene, in an ether is used as a catalyst.

E. R. Kanhofer. U.S.P. 2,234,177, 11.3.41. Appl. 4.11.38. Method of polymerization of normally gaseous olefins in the presence of a solid polymerizing catalyst to produce polymer gasoline therefrom.

E. T. Layng. U.S.P. 2,237,822, 8.4.41. Appl. 9.11.39. Method of conversion of olefinic hydrocarbons into hydrocarbons of higher boiling points by polymerization. The olefinic hydrocarbons are contacted at elevated temperature with a catalytic contact agent comprising as an essential ingredient an acid metal pyrophosphate selected from the group consisting of $CuH_2P_2O_7$, $HgH_2P_2O_7$, $ZnH_2P_2O_7$, $MgH_2P_2O_7$, $Fe_3H_4(P_2O_7)_3$, $Al_2H_4(P_2O_7)_3$, and $CoH_2P_2O_7$.

K. Frolich and F. L. Miller. U.S.P. 2,239,501, 22.4.41. Appl. 12.12.33. Process for increasing the stability of hydrocarbon polymers by partly decomposing a mixture of linear substantially saturated hydrocarbon polymers which are oil-soluble and contain unstable constituents of relatively high molecular weight. The unstable components are broken down to constituents of lower molecular weight. H. B. M.

Synthetic Products.

608.* The Nitroparaffins. C. L. Gabriel. *Industr. Engng Chem.*, 1940, **32** (7), 887.—The large-scale production of nitroparaffins opens up a new chapter in the development of the synthetic organic chemical industry. The first commercial unit for the manufacture of nitroparaffin started production at Peoria, Illinois, during 1940. Nitromethane, nitroethane, 1-nitropropane, and 2-nitropropane are being made in this plant. The above four lowest members of the nitroparaffin series are simultaneously formed when propane and nitric acid and nitrogen oxides are contacted at elevated temperatures. The nitroparaffins are separated as a crude reaction product from unconverted propane and nitrogen oxides. The individual nitroparaffins are then obtained by distillation and chemical purification. The main emphasis of this article is placed on the various chemical reactions of the nitroparaffins, which are discussed in some detail. Although many hundreds of organic compounds have been synthesized from nitroparaffins, the commercial utilization of this class of compounds offers wide scope in the field of organic synthesis. H. E. T.

609.* Synthetic Chemicals from Petroleum. L. Rosenstein. *Oil Gas J.*, 14.11.40, **39** (29), 118. *Paper presented before Refining Division of A.P.I. Chicago, November* 1940.—The development in the production of synthetic chemicals from petroleum and natural gas by a major oil company is discussed and details are given of methods of production, properties, and applications of these products. Products manufactured include ammonia and ammonium sulphate (using sludge acid), *sec.*-buytl alcohol, *tert.*-butyl alcohol, *iso*propyl alcohol, acetone, methyl ethyl ketone, methyl *iso*butyl ketone, mesityl oxide, diacetone alcohol, *iso*propyl acetate and *sec.*-butyl acetate, *iso*propyl ether and carbon. A wide range of chemicals derived from the olefins by chlorination is produced on the semi-commercial scale, as also is butadiene. Possible development include the production of ethyl alcohol, glycol, and glycol ethers from ethylene, derivatives of acetylene (which can be produced from methane), etc.

The products have a high degree of purity and uniformity, their production entailing the development of special analytical procedures. Removal of *iso*butylene from the

butylenes used for *sec.*-butyl alcohol synthesis by absorption in cold H_2SO_4 has led to the production of *iso*-octane on the large scale and to the development of the hot-acid polymerization and the alkylation processes. C. L. G.

610. Synthetic Super-fuels and Super-lubricants. C. H. Berthelot. *Chim. et Ind.*, Vol. 43, No. 7, April 1940, 538/548.—1. Reactions involved in the polymerization of olefines. Paper presented by Dr. Egloff at the Congres de Association Française pour l'Avancement des Sciences at Liége in July 1939.

Details are given of the polymerization process used by the U.O.P. This consists of isolating the butane contained in cracked gases and dehydrogenating to obtain a mixture of butane/butenes. The C_4 olefines are then polymerized at 250° C. and 40 atmos., the reaction taking place in the presence of phosphoric acid adsorbed on silica gel. In order to obtain the maximum yield it is essential that the butane/butenes should contain a certain percentage of water. The polymers are then rectified in two columns; the first serves to debutanize the polymers, the second separates the dimers (octenes) from the trimers. Finally, the dimers are hydrogenated in the presence of nickel and give octanes. The above results have also led to attempts to polymerize propene to produce *iso*hexane.

By hydrating 2 molecules of propene with 1 molecule of water, *iso*propyl ether is obtained, this substance having an anti-knock value slightly superior to that of pure *iso*octane. *iso*Propyl ether can be prepared from the propylene contained either in cracked gases or produced by the pyrolysis of natural gases. The C_3 hydrocarbons are easily separated from the rest by fractionation in a column fitted with plates, and are then treated under pressure in a scrubbing-tower with 75% H_2SO_4 at about 30° C., producing *iso*propyl/sulphuric acid and free propane

$$CH_3 - CH = CH_2 + H_2SO_4 \longrightarrow \begin{matrix} CH_3 \\ CH_3 \end{matrix}\!\!>\!C\!<\!\!\begin{matrix} H \\ O - HSO_3 \end{matrix}$$

Hydrolysis of the acid solution gives *iso*propyl alcohol, which is then dehydrated by heating to about 100° C. The reaction is somewhat complex, and yields not only *iso*propyl ether, but also *iso*propyl alcohol and propylene, whilst the sulphuric acid is regenerated. The reaction products are separated by distillation followed by a rectification of the more volatile bodies, the propylene, acid, and alcohol being recycled for further reactions. *iso*Propyl ether is stated to be a dangerous compound owing to the ease with which it forms explosive peroxides under the action of heat. The explosive substance is largely the peroxide of tri-acetone, and it is only necessary to add a very small proportion of an anti-oxidant to prevent its formation. The anti-oxidant also acts as an inhibitor, and confers on the blends containing the *iso*propyl ether a very high stability. It is stated that from a European point of view *iso*propyl ether is cheaper to manufacture than *iso*-octane.

The U.O.P. process can also be used in the production of explosives by the transformation of aliphatic hydrocarbons into aromatics. The cycle is briefly as follows:

Hexane, heptane, or normal octane are treated in the presence of a catalyst (salts of chromium, molybdenum, or tungsten) adsorbed on alumina or clay. The reaction is carried out at about 700° C. and at atmospheric pressure, and yields benzene, toluene or orthoxylene.

For hexane the reaction is as follows:

$$CH_3 - (CH_2)_4 - CH_3 \longrightarrow C_6H_6 + 4H_2$$

and semi-plant-scale yields are stated to be about 75–90%. Owing, however, to parasitic reactions, the yield is in normal industrial practice below this figure, mainly due to the deposition on the catalyst of gums and tarry substances produced by the polymerization of certain olefines inevitably formed during the reaction.

M. M. L.

611.* Synthetic Rubbers. L. A. Wood. *Engineering*, 1940, **150**, pp. 316, 335, 356, and 419.—The trade names, manufacturers, and countries of origin of some thirty synthetic rubbers are given. These commercial products belong to ten chemical types. The structure of the monomer and unit polymer of each of these types is described, together with the principles of the syntheses. The physical properties

are tabulated—viz., density, refractive index, electrical conductivity, dielectric constants, tensile strength, elongation, molecular weight, permeability to gases, water, and organic compounds, resistance to swelling in contact with petroleum products and organic solvents, and abrasion resistance. In general it is concluded that there are possibilities for use of synthetic rubbers in every application of natural rubber and in additional fields from which natural rubber is barred by some of its deficiencies. No synthetic rubber has so wide an application as natural rubber, but for a given application it is usually possible to select a type of synthetic rubber which excels natural rubber in some property of importance in that application. The values of certain of the specific uses of synthetic rubber are discussed. J. W. H.

612.* Synthesis and Octane Numbers of Some Unsaturated Alcohols and Diolefin Hydrocarbons. K. I. Karasev and A. V. Khabarova. *J. General Chem. U.S.S.R.*, 1940, **10** (18), 1641–1646. Translation by A. A. Boehtlingk. *For. Petrol. Tech.*, Feb. 1941, **9** (2), 42.—The following alcohols were synthesized: 5-methylhexene-1-OL-4, heptene-1-OL-4, heptene-2-OL-4, octene-2-OL-4, 6-methylheptene-2-OL-4, and the hydrocarbons heptadiene-1 : 4, heptadiene-2 : 4, 5-methylhexadiene-1 : 4, octadiene-1 : 4, and 6-methylheptadiene-2 : 4. The octane numbers were determined by the "Vokesh" method with an apparatus of the C.F.R. No. 3 type. The sulphone numbers were also determined to indicate the susceptibility of the hydrocarbons obtained to oxidation, and some constants of the chlorine and bromine derivatives were also investigated. Although the hydrocarbons had a high octane number (up to 130 O.N.), it was not sufficiently high to justify their utilization as anti-knock additions to motor fuels; moreover, their high oxidation ability would render them unsuitable for this purpose. Exceptions were found in the case of hydrocarbons with a normal structure with bonds in the 1 : 4-position which could be stored for quite a long time in contact with air without change. B. M. H. T.

Refining and Refinery Plant.

613.* Production of Aviation Motor Fuel from Natural Gasoline. K. E. Cody and D. M. Luntz. *Refiner*, April 1941, **20** (4), 112–116.—This article presents the results of evaluations which were made of two different natural gasolines to determine their potentialities as sources of base-stocks for the manufacture of aviation motor fuel. It was found that one of them contained appreciable quantities of a good base material, whilst the other was unsuitable for this purpose. This difference illustrates the danger inherent in failing to get accurate information as to the character of each stock it is desired to process. Thus, from a study of the results of the first evaluation it might have been erroneously concluded that a suitable-quality aviation fuel can be made from any natural gasoline by the method used.

The procedure consisted of debutanization, depentanization of the butane-free bottoms, since this butane-free material had too high a vapour pressure and was too light to meet the aviation distillation specifications, and then fortification of the depentanized material (with *iso*pentane) to meet the requirement of 7 lb. Reid vapour-pressure. *iso*Pentane was used as the blending agent, since in this way the clear octane number of the blend was made higher than if a mixture of normal and *iso*-pentane had been used. (*iso*Pentane's octane rating is about 92, whilst that of normal pentane is about 60.) Although other blending agents, such as alkylate, *iso*octane, *neo*hexane, or any combination of these, could have been used, they are not contained in the charge stock, as is the *iso*pentane, and, in addition to being less readily available, would be more expensive. At any rate, it is felt that the method used has the advantage of simplicity and gives results that are indicative of the ease or difficulty with which aviation gasoline can be made from the stock processed. A. H. N.

614.* Water Conditioning by Evaporator Method. L. L. Wakefield. *Refiner*, April 1941, **20** (4), 117–120.—The paper is confined to conditioning boiler-feed water and for engine-jacket cooling water by evaporator methods. The purpose of a water-conditioning system is to modify or eliminate the solids in the make-up water. Properly designed evaporators for providing distilled make-up water will keep the amount of total solids in the make-up water well below one-half grain/gall., which is equivalent to elimination of solids, even though the water fed to the evaporator has a

concentration of 150–200 times this amount. However, it must not be considered that evaporation is the optimum treatment for all boiler-make-up waters.

Formerly the high percentage of boiler-feed make-up required in the typical industrial plant involved such a large investment for evaporators that usually it was difficult to justify their purchase. In recent years many improvements in the design of operating equipment have brought about reductions in water losses, thus reducing the amount of make-up required, and the practical and economical application of evaporators has been extended to an increasing number of industrial plants.

There are many and varied evaporator installations, but most of them will fall into one of the following three general classifications: (1) single-effect evaporators; (2) multiple-effect evaporators; (3) reducing-valve evaporators. These are briefly described.

A typical evaporator system is used to illustrate the problems of designing and working evaporator systems. The heating medium in the evaporator tubes is high-pressure steam (185 lb. gauge) direct from boilers. Condensate from these tubes is discharged by trap into a hot condensate header. Heated raw water from the raw-water heater enters the evaporator shell around the tubes, and high-pressure steam through the tubes.

Scale deposition on the outside of evaporator tubes is cracked off in the following manner: Steam to the tubes is shut off; evaporator is then quickly emptied through the 6-in. blow-down line; after which steam is opened full into tubes, expanding them to their maximum curvature (the tubes in the tube-bundle are of the bent-tube type); steam is again shut off and cold water is turned on full into the evaporator, completely submerging tube-bundle and splash-plate, thus contracting the tubes to their minimum curvature, cracking off the scale; evaporator is again emptied through the 6-in. blow-down line to wash out the loose scale; raw water is again turned into the evaporator, filling it to the proper level, and the operation starts another cycle.

A. H. N.

615.* Gum and Sulphur Removed from L.P.G. by Filtering. Anon. *Refiner*, April 1941, **20** (4), 127.—This filter is a vertical drum with a welded head at the top containing a 4-in. collar closed with a bull-plug. The collar is used for refilling the filter after cleaning. The filter-case is mounted on a 2-in. pipe tripod support set in concrete at the base of the filter. The lower end of the case has a flange welded to the body, to which may be connected a companion flange containing a drum-shaped head and the liquid outlet line. Between the two flanges is placed a slotted plate covered with a strip of filter cloth on which is placed 4 in. of hair felt to prevent the filtering agent from passing through the slotted supporting plate. The capacity of the case is 800 lb. of activated clay from Muroc Dry Lake in the Mojave Desert.

Since this filter has been placed in operation, all regulating equipment on engines using this fuel is free from the gummy film and all equipment is operating without disturbance. Tests on the filtered liquid with copper strips show no deposit or discoloration. Not only have the gums and sulphur been removed, but the product passes to storage tanks free from suspended water.

A. H. N.

616.* Choice of Charging Stocks to Make High-Octane Fuels. H. N. La Croix. *Oil Gas J.*, 5.12.40, **39** (30), 50.—The new processes developed in the refining industry are highly dependent on chemical affinities and reactions, and successful operation requires consideration of equilibrium distributions, laws of mass action, and physical chemistry.

The preparation of high-octane gasolines is economically beyond the scope of simple thermal cracking, and requires the use of special processes—*e.g.*, polymerization, alkylation, etc.

The charging stocks are usually light hydrocarbons, and these are normally contaminated with organic impurities such as N or S compounds, which reduce the effective life of the catalysts employed. H_2S is one of the worst impurities from this point of view. It can, however, be easily removed by a number of methods, of which the most economical is the phosphate process.

One of the latest plants using this process is a liquid-extraction unit preparing liquid hydrocarbons for charging to a U.O.P. catalytic polymerization plant. This employs the Shell phosphate process using aqueous solutions of tri-potassium phosphate for removing H_2S.

The phosphate process is being used in many plants, and is attracting increasing attention of refiners as a simple and economical means of disposing of H_2S, and is especially valuable in the preparation of high-octane blending fuels. D. L. S.

617.* World Oil Refineries Survey. Anon. *Oil Gas J.*, 26.12.40, **39** (33), 66, 93.—A list is given of the location, type of plant, and the distillation and cracking capacity of the oil refineries of the world, including the U.S.A. C. L. G.

618.* Toluene-Benzene Purification. W. T. Ziegenham, *Oil Gas J.*, 2.1.41, **39** (34), 34.—A description is given of a chemical treating plant and fractionating unit with an unusually high degree of flexibility designed to recover practically pure benzene and toluene from coal-tar distillates of toluene content from 6 to 35%. The plant has a capacity of 20,000 gals. of coal-tar distillate per day, producing toluene and benzene distilling within a boiling range of 1° C., passing the Barrett acid wash No. 1 test, and showing negative corrosion, acidity, and H_2S test. Colours are 25+ and the benzene has a solidification point of +5° C.

The distillate is washed twice with 2% of acid (first with recycled, and then with new acid), caustic washed, and passed, after settling, to the fractionating unit, consisting of two 61-ft. columns. During the first run light paraffinic hydrocarbons are taken from the top of the first tower, and the residue, after reboiling, is passed to the second tower, where 1° benzene is taken off the top. The residue, containing toluene and xylene and higher-boiling oils, is charged to the unit during a second run, some further benzene being taken off the first tower and the 1° toluene off the second tower. The residue is refractionated to produce 3° xylene and heavy residue (sold for recovery of heavy coal-tar naphtha, resins, etc.). Particular attention is paid to efficient cooling and adequate instrumentation. C. L. G.

619.* Copper-Chloride Treater Handles Straight-Run or Cracked Gasolines. Anon. *Oil Gas J.*, 10.4.41, **39** (48), 15.—At a refinery at El Dorado, Arkansas, a copper-chloride-treating plant has been installed which eliminates injurious S and gum-forming compounds from gasolines. This apparatus consists of two systems: one for straight-run material and the other for cracked products.

Consumption of chemicals is low, due to complete rejuvenation of the active constituent, and the treated gasoline in many cases shows an increased lead susceptibility. Stabilized cracked gasoline is given a caustic wash followed by a water wash, and is then passed through a salt drum where moisture and some organic acids are removed. From there it passes to the chemical reactor, where it is contacted with copper chloride and treated with oxygen. D. L. S.

620.* Small Refinery Major Factor in Peru. J. P. O'Donnell. *Oil Gas J.*, 10.4.41, **39** (48), 15.—A small refinery of 1000 brl./day capacity has been constructed and is now operating at Zorritos, Peru. This, it is hoped, will supply 30% of Peru's motor fuel, 21% of its kerosine, and 12·5% of its fuel needs.

The bulk of the charging stock is a sweet, low cold test 35–40° A.P.I. gravity crude from Lobitos, the balance being obtained from a Government-operated field. The products are of high quality and need no subsequent treatment, yields on the initial run approximating 37% gasoline, 11·5% kerosine, 15% diesel oil, and 34% fuel oil.

The crude is taken to Zorritos in shallow-draft coastal tankers, and is delivered to the refinery by an 8-in. submarine line extending 1 mile into the ocean.

Processing equipment is entirely conventional, and the fractionating tower was shipped from the U.S.A. in sections. D. L. S.

621.* Solvent Extraction of Oils. *Engineering*, 1940, **150**, 496.—Types of plant for the solvent extraction of oil from waste materials, oil seeds, fuller's earth, etc., are described. Construction materials for use with various solvents are discussed, and the provision of solvent recovery equipment by distillation and absorption is dealt with. J. W. H.

622.* Heat Insulation on Cylindrical Surfaces. C. Turner. *Industr. Engng Chem.*, 1940, **32**, 904.—A graphical method is presented for the rapid estimation of heat-

flow through cylindrical lagging. A multiplication factor is used to correct the heat-flow from a flat surface to that of a cylindrical surface having the same thickness of lagging. This factor varies with the ratio of the cylinder diameter to the diameter of insulation. J. W. H.

623.* Multi-component Rectification : Optimum Feed-Plate Composition. E. R. Gilliland. *Industr. Engng Chem.*, 1940, **32** (7), 918.—Equations are derived by means of which the optimum feed-plate composition, expressed in terms of light and heavy key components, may be calculated for three conditions of the feed—namely, all-liquid, partly vaporized, and superheated vapour. P. D.

624.* Action of Solutizers in Mercaptan Extraction. D. L. Yabroff and E. R. White. *Industr. Engng Chem.*, 1940, **32** (7), 950.—Aqueous caustic solutions containing certain organic solvents or organic salts (" solutizers ") are much better than straight aqueous caustic solutions for the extraction of mercaptans from gasolines.

A study of the action of solutizers indicated that, as expected from previous investigations, organic solvent solutizers increase the solubility of unneutralized mercaptan in the alkaline phase, thereby leading to a more complete mercaptan removal from the oil phase. Organic salt solutizers, on the other hand, exert a salting-out effect on the unneutralized mercaptan at low solutizer concentrations, but this effect is reversed at high solutizer concentrations. In addition, both types of solutizer appear to eliminate the marked salting-out effect of sodium hydroxide which was observed previously with unsolutized caustic-soda solutions. The paper gives the main results of a cursory examination on the rôle played by solutizers by a study of the constants involved in a simple extraction.

The organic solutizers employed were methanol and glycerol, whilst the organic salt solutizer was sodium *iso*butyrate. H. E. T.

625*. Multi-component Distillation Problems. H. J. Hibshmann. *Industr. Engng Chem.*, 1940, **32** (7), 988.—A graphical method for the estimation of plate compositions in multi-component distillation problems is given and an example worked out. The example chosen is one which has already been solved by two other methods, and direct comparison is possible. The method involves the construction of a Cox vapour-pressure chart on a transparent sheet. These vapour-pressure lines are used as equilibrium lines, and by appropriate superimposition of this chart on a graph of the vapour-liquid operating lines, the compositions present on any plate may be read off at any desired operating pressure. J. W. H.

626*. Multi-component Rectification. E. R. Gilliland. *Industr. Engng Chem.*, 1940, **32** (9), 1220.—A method of estimating the number of plates and reflux ratio to give any required separation is derived in which a function of the terms actual number of plates and minimum number of plates at total reflux is plotted against a function of the terms actual reflux ratio and minimum reflux ratio (at infinite plates). The number of plates at total reflux is estimated by Fencke's equation; and the minimum reflux ratio by the method proposed by the author (*Industr. Engng Chem.*, **32**, 1101).

The relation between the functions is an empirical one, and is derived by plotting the results of sixteen calculated separations, of which details are given. P. D.

627.* Calculation of Absorber Performance and Design. G. Horton and W. B. Franklin. *Industr. Engng Chem.*, 1940, **32** (10), 1384.—General equations for absorption and stripping factors are derived. The derivation is free from assumptions which made the equations of previous investigators of doubtful utility. The method of use is illustrated by examples. P. D.

628.* Factor *C* in the Performance of Ejectors. L. T. Work and A. Miller. *Industr. Engng Chem.*, 1940, **32** (9), 1241.—Experimental work on two ejectors on vapours of varying molecular weight was previously reported (*Industr. Engng Chem.*, **32**, 464).

These results are correlated in the present paper, where it is shown that an equation of the following form holds for both ejectors:

$$C = 1 - (aM_b/M_e + b)(w/W)(P_b/P_n)^n$$

where:

C	$= (Pn - Pe)/(Pn - Po)$.
P_b	= boiler pressure.
P_o	= exhaust pressure.
P_e	= entraining pressure.
P_n	= suction pressure (no entrainment).
w/W	= weight ratio of evaporator to boiler fluids.
M_b	= molecular weight of boiler fluid.
M_e	= molecular weight of entrained fluid.
a, b, n	= constants.

Values of a, b, and n for the two ejectors are given. P. D.

629.* **Mechanism of Desulphurization of Distillates with Zinc Chloride.** K. A. Musatov and L. G. Krymova. *J. appl. Chem.* (*U.S.S.R.*), 1940, **13** (2), 227–234. Translated by A. A. Boehtlingk. *For. Petrol Tech.*, Feb. 1941, **9** (2), 61.—The vapour-phase method of desulphurization adopted to the treatment of distillates with solid zinc chloride is described. Of decisive importance in the degree of desulphurization of the distillates and in the combination of hydrogen sulphide are the oxygen compounds of zinc chloride (hydrate, and oxide).

If due attention is paid to this in the rational selection of carriers (with hydrate characteristics) at the most favourable process temperature close to the optimum temperature of catalytic cracking in the presence of zinc chloride, it is possible to desulphurize sulphur containing distillates of the Ishimbaevo crude oils to limits close to the technical specifications for the permissible content of sulphur. In the desulphurization by this method, hydrogen sulphide and hydrogen chloride do not separate. B. M. H. T.

630. **Patents on Refining and Refinery Plant.** I. M. Colbeth. E.P. 534,338, 5.3.41. Appl. 4.8.39.—Apparatus for purifying crude oils in which the oil is divided into small droplets in the solution and the solution and oil are caused to pass by gravity in a counter-current relationship with each other at a speed which allows the impurities to be extracted without causing emulsification. The apparatus can be employed in the purification of petroleum oils containing naphthenic acids.

N. V. de Bataafsche Petroleum Maatschappij. E.P. 534,543, 10.3.41. Appl. 4.2.39. Process for the purification and decoloration of ketones and/or ketols or of mixtures containing same which are discoloured by the presence of colour-imparting impurities. The discoloured material is treated with ammonia and/or primary amines until substantially free from impurities and discoloration.

N. V. de Bataafsche Petroleum Maatschappij. E.P. 535,431, 9.4.41. Appl. 6.11.39. Method of removing a body of coke from the reaction chamber of an oil-cracking plant. First the body of coke is cut by impinging a substantially confined jet of water on to it. Thereafter the resulting lumps of coke, fines, and liquid are removed from the chamber.

Texaco Development Co. E.P. 535,449, 9.4.41. Appl. 31.1.40. Method of dewaxing lubricating oil containing relatively small amounts of wax, or from which the wax is precipitated in relatively dense form. The procedure is particularly useful in the dewaxing of residual cylinder stocks which tend to form relatively dense and compact filter cakes.

L. U. Franklin. U.S.P. 2,235,921, 25.3.41. Appl. 24.2.37. Method of sweetening a sour petroleum distillate by passing through a pervious bed of small, non-absorbent, non-porous, inert solid particles moistened with an aqueous medium containing cupric and chloride ions, which is capable of reaction with mercaptans present in the distillate to form disulphides and cuprous chloride capable of regeneration. Sufficient

moisture is applied to the bed to supplant that removed in excess by entrainment in the distillate and to maintain the bed in a uniformly moist condition.

W. B. Lerch, C. H. Mathis, and E. J. Gatchell. U.S.P. 2,235,936, 25.3.41. Appl. 20.6.38. Process for the removal of sulphur compounds from hydrocarbons by passing the hydrocarbons through a bed of dry cyanamide.

A. L. Lyman, R. C. Mithoff, and H. B. Nichols. U.S.P. 2,236,216, 25.3.41. Appl. 6.12.38. Process for the catalytic desulphurization of hydrocarbons consisting in major part of liquid acyclic mono-olefins.

L. D. Jones. U.S.P. 2,237,670, 8.4.41. Appl. 2.12.38. In the dewaxing of hydrocarbon oils a mixture is used as diluent which contains symmetrical dichloroethane and trichloro ethylene in a ratio adapted to cause precipitation of wax from petroleum stock without substantial precipitation of paraffinic oil. The mixture also contains sufficient dichloromethane to render the resulting mixture non-inflammable.

H. B. M.

Chemistry and Physics of Petroleum.

631.* High-Pressure Absorption in Gas-Cycling Operations. L. S. Reid. *Refiner*, April 1941, **20** (4), 103–111.—The general characteristics of condensate reservoir fluids are reviewed. The advent of the high-pressure-absorption process into the field of gas cycling is due to certain inherent limitations of the existing condensation processes. One of the most important of these limitations is the large compression ratio often required to increase the pressure of the residue gas from the optimum condensation pressure to that pressure required to inject it into the formation from which it came. Thus with a fluid which has an optimum condensation pressure of 1000 lb./sq. in., if a pressure of 3000 lb./sq. in. were required to return the residue gas to the formation, the resulting compression ratio of 3·0 would require approximately 62 brake horse-power/million cu. ft. of gas handled. If, on the other hand, this same reservoir fluid could be processed at 2000 lb./sq. in., the compression ratio of 2·0 would require 38 horse-power/million cu. ft. of gas. Similarly, by processing at 1500 lb./sq. in., the compression ratio of 1·5 would require 23 horse-power/million cu. ft. of gas handled by the compressor.

A second important limitation of condensation processes is the relatively low extraction efficiencies obtained even when operating under optimum pressure conditions. Extraction efficiency may be expressed by the equation: Percent Extraction Efficiency $= \frac{V_r - V_g}{V_r} \times 100$, where V_r = total volume of desirable hydrocarbons in the reservoir fluid expressed in galls./thousand cu. ft., and V_g = total volume of desirable hydrocarbons remaining in the residue gas after processing, expressed in gallons/thousand cu. ft. of reservoir fluid processed.

This relationship applies only to the liquid which is extracted from the reservoir fluid either by absorption or by condensation, and is thus made available for stabilization and processing to finished products.

Laboratory investigations and field studies of the displacement of reservoir fluids by dry residue gas injected into condensate reservoirs indicate that a single cycle of residue gas will result in the production of from 50% to 60% of the original reservoir fluid. In other words, if a condensate pool were properly drilled and produced by cycling operations, from 50% to 60% of the original reservoir fluid would have been produced and processed by the time the residue gas breaks through into the producing wells and dilutes the rich gas. Cycling operations cannot continue long after this dilution sets in, and new producing wells must be drilled, or the project must be shut down and abandoned. It is imperative, therefore, to make every effort to secure maximum condensate recovery at minimum cost, and to this end the oil-absorption process has been adapted to gas-cycling operations.

Typical counter-current and concurrent absorption plants are discussed and illustrated. Extensive research on the behaviour of hydrocarbon mixtures at elevated pressures, coupled with experience gained from plant operations during the past two years, has resulted in the extension of satisfactory absorber performance from a pressure

of 1200–1900 lb./sq. in. in counter-flow absorption processes, whilst the concurrent process is reported to operate satisfactorily at 2000 lb./sq. in. A. H. N.

632.* Elements of Vaporization and Condensation. Part XIII. R. L. Huntington. *Refiner*, April 1941, **20** (4), 133–136.—It has been found that the blending of small percentages of stabilized natural gasoline with crude oil offers several economic advantages in the transportation and storage of these commodities. There are, however, certain unfavourable factors which arise from this blending practice, such as: (1) increased vaporization losses in storage; (2) fire and explosion hazards in cleaning out tank bottoms which have settled out of crude-oil–natural-gasoline blends.

The first advantage to be recognized from the pipe-line transportation of the crude-oil–natural-gasoline blends was the large saving in freight. In the early twenties heavy withdrawal losses were experienced in the tank-car shipment of unstabilized gasoline. By blending from 1% to 2% of this "wild" gasoline with crude oil, vaporization losses were reduced materially below those suffered through rail transportation.

Reduction in the viscosity of the crude oil is another factor in favour of blending. This change in the physical property of the liquid brings about a saving in horse-power required to pump the crude, due to the lowering of friction losses.

Blending operations are also found to be desirable for some crudes which are high in paraffin-wax content. The natural gasoline acts as a solvent under certain conditions, thereby lessening the tendency for wax to form a coating on the inside walls of the pipe-line. The alternative of heating the crude and maintaining it at a temperature above the pour-point is entirely out of the question for long pipe-lines in cold weather. One company has increased its crude-oil deliveries 50% by blending natural gasoline (10% by volume) with crude oil in the winter season. This crude has a pour-point to 55° F., due to its high wax content. Evaporation losses were not excessive, as much smaller percentages of gasoline were required in summer to effect the same delivery capacity for the pipe-line.

Experimental data and laboratory technique to evaluate vaporization losses through wind and weather actions are presented. A. H. N.

633.* Use of Azeotropic Distillation in Separating Hydrocarbons from Petroleum. F. D. Rossini, B. J. Main, and A. R. Glasgow. *Oil Gas J.*, 14.11.40, **39** (27), 158. *Paper before Refining Division of A.P.I., Chicago, November* 1940.—The principles of azeotropic distillation, its use in the laboratory preparation of pure hydrocarbons, and its commercial possibilities are discussed. Reference is also made to the advantages of distillation under reduced pressure. Nearly all polar organic compounds with the proper volatility form minimum boiling azeotropic mixtures with hydrocarbons, paraffin hydrocarbons giving the lowest boiling point and aromatic hydrocarbons the highest. With binary azeotropic mixtures, the boiling point and the composition of the mixture approach, with increase in boiling point of the hydrocarbon, those of the pure azeotrope-forming compound. The products most successfully used in laboratory hydrocarbon separation include methyl alcohol, ethyl alcohol, methyl cyanide, acetic acid, ethylene glycol monomethyl ether acetate, ethylene glycol monobutyl ether, and diethylene glycol monomethyl ether.

Owing to the fact that the boiling points of aromatics hydrocarbons decrease more rapidly with decreasing pressure than naphthenes and the latter more rapidly than paraffins, separation is enhanced by distillation under reduced pressure.

Commercial applications of azeotropic distillation in use include the use of benzene or trichlorethylene to dehydrate ethyl alcohol, and the removal of low-boiling aldehydes from commercial dioxane by the addition of water and a volatile inorganic acid.

C. L. G.

634.* Catalytic Isomerization of Butane Yields 67–74% *iso*Butane. B. Moldavskii and T. Nizookina. *Nat. Petrol News*, 27.11.40, **32** (48), R 422.—The isomerization of *n*-butane with Al_2Cl_6 catalyst has been studied and the equilibrium composition of the resulting mixture at various reaction temperatures from 70° to 180° C. determined by Podbielniak fractionation. At 70° C. isomerization in the liquid phase of *n*-butane, *iso*butane, and mixtures led to the formation of an equilibrium mixture containing 73·9–74·3% *iso*butane and 26·1–25·7% *n*-butane, without formation of by-products. At higher temperatures decomposition takes place with the production of propane

and methane. It has been shown that equilibrium concentrations given in the literature and based on theoretical calculations do not agree with those determined experimentally. C. L. G.

635.* Constitution Diagrams and Composition of Methane and Ethane Hydrates. O. L. Roberts, E. R. Brownscombe, and L. S. Howe. *Oil Gas J.*, 5.12.40, **39** (30), 37.—Gas hydrates have been studied recently from many angles. The present paper deals with the relation of the usual hydrate curve to the other equilibria curves for the water–methane and water–ethane systems. Use of the vapour–ice–hydrate data as well as the vapour–liquid–hydrate equilibrium, together with the incorporation of the compressibility factor of the gas, make possible a thermodynamically sound method of calculating hydrate composition.

A description of the apparatus, illustrated by a diagram and a photograph, is included. The results obtained are given in the form of a number of phase diagrams showing data over the temperature range 10–60° F.

Compressibility factors for ethane vapour have been determined at pressures ranging from 5 to 32 atmospheres at 32° F. and 54° F.

The heats of formation of methane and ethane hydrates from vapour and water and from vapour and ice have been calculated from the foregoing equilibrium data, correcting for the deviation of the gases from the ideal gas laws.

The composition of the gas hydrates has been calculated from equilibrium curves as follows: The heat of formation of hydrate per mol. of combined gas is determined for its formation from liquid water and gas and for its formation from ice and gas. The difference between these two represents the heat of fusion of the water present in hydrate with 1 mol. of gas. Dividing this heat by the heat of fusion of 1 mol. of water gives the number of mols. of water per mol. of gas in the hydrate. The composition of the hydrates has been found to be $CH_4 \cdot 7H_2O$ and $C_2H_6 7H_2O$. D. L. S.

636.* Formation of Propylene by Dehydrogenation of Propane. M. Kurokawa and Y. Takenaka. *J. Soc. Chem. Ind. Japan*, Feb. 1941, **44** (2), 45B–47B.—Results are given of experiments on the catalytic and non-catalytic decomposition of propane, carried out with the object of preparing propylene from propane by dehydrogenation. The optimum temperature for dehydrogenation of propane was found to lie between 600° and 650° C. The ratio C_3H_6/C_2H_4 increases with increase of gas velocity. Consequently, increase in gas rate facilitates dehydrogenation to a certain extent by breaking the C–H bond of propane and preventing the splitting of the C–C bond. Of the catalysts employed (UO_2, CuO, AgO, Al_2O_3, and Mn_2O_3), UO_3 was found to be the best, having the least reversible activity. B. M. H. T.

637.* Boiling Points of Benzene, 2 : 2 : 3-Trimethylbutane, 3-Ethylpentane, and 2 : 2 : 4 : 4-Tetramethyl Pentane within the Range 100–1500 mm. of Mercury. E. R. Smith. *Bur. Stand. J. Res.* (*Wash.*), 1941, **26** (2), 129–134.—The comparative method of Swietoslawski using water for the reference standard was used for this work. The benzene for these measurements was prepared during a previous fractionation; the other hydrocarbons were obtained from the Automotive Power Plant Section of the Bureau of Standards. Temperatures were measured to 0·001° C., and, having regard to the degree of purity of the hydrocarbons, it is believed that the results are accurate to better than 0·01°.

Data have been obtained from which were developed the following equations expressing the relationship between temperature and vapour pressure in the range of pressures 100–1500 mm. Hg:

Benzene :

$$\log_{10} p = 6{\cdot}905216 - \frac{1211{\cdot}215}{220{\cdot}870 + t}$$

2 : 2 : 3-*Trimethylbutane :*

$$\log_{10} p = 6{\cdot}799682 - \frac{1204{\cdot}997}{226{\cdot}615 + t}$$

3-*Ethylpentane :*

$$\log_{10} p = 6{\cdot}873058 - \frac{1249{\cdot}825}{219{\cdot}595 + t}$$

For 2 : 2 : 4 : 4-tetramethylpentane no single equation was found to fit the data sufficiently accurately over the entire pressure range. The following two equations have been developed :

(*a*) From 100–450 mm. :

$$\log_{10} p = 6{\cdot}643408 - \frac{1231{\cdot}620}{204{\cdot}975 + t}$$

(*b*) From 430–1500 mm. :

$$\log_{10} p = 6{\cdot}860684 - \frac{1368{\cdot}925}{221{\cdot}679 + t}$$

In these equations p is the vapour pressure in standard mm. of Hg exerted by the substance at temperature $t°$ C. D. L. S.

638.* Effect of Pressure on the Enthalpy of Benzene. E. R. Gilliland and R. V. Lukes. *Industr. Engng Chem.*, 1940, **32** (7), 957).—Apparatus is described by means of which the isothermal change of enthalpy accompanying an expansion of a vapour from elevated pressure to one atmosphere can be measured. Measurements were made on benzene vapour up to pressures of 190 atms. P. D.

639.* Drying Oils and Resins. T. F. Bradley and D. Richardson. *Industr. Engng Chem.*, 1940, **32** (7), 963.—Ultra-violet absorption methods have been applied to a series of samples prepared in the course of a fundamental study of the mechanism of the polymerization of some drying oils. Partial interpretation of the absorption curves has been accomplished through studies of analogous and related compounds.

For the ultra-violet absorption measurements, a large Hilger, type E. 492, quartz prism spectrograph was used in conjunction with a Hilgar-Spekke photometer. Specially purified hexane *cyclo*hexane was used as the solvent, and the solutions were examined in an adjustable micrometer absorption cell with quartz and plates. The absorption curves are plotted in terms of the logarithm of the extinction coefficient k (ordinates) defined as

$$k = d/Lc$$

where d = optical density $\left(\log \dfrac{\text{incident light}}{\text{transmitted light}}\right)$

L = length, in cms., of solution of concentration c, in grams per 100 c.c. through which the light passes,

and with wave number as abcissæ, *i.e.*, reciprocal of wave-length in cm.

Absorption curves for the following hydrocarbons are given : hexane, *cyclo*hexane ; 3-hexene (containing conjugated diene) ; *cyclo*hexene, dimethylbutadiene ; 1 : 3-*cyclo*hexadiene ; a-eleostearic acid, and *p*-cymene. Absorption curves were also obtained for :

(*a*) Tripalinetin, tristearin, methyl oleate (contained dienes) ; methyl oleate (after treatment with maleic anhydride) ; methyl ester of Neo Fat 3R (mainly 9 : 12 linoleate) ; 9 : 11 linoleic acid ; and ethyl linoleate.
(*b*) A series of linseed oils, heat bodied in a vacuum at 575° F.
(*c*) Methyl esters of linseed oil.
(*d*) Tung oils and esters.
(*e*) Castor-oil esters.
(*f*) Esters of soya-bean oil, olive oil, Oiticica and sardine oils and their esters.

From these observations it is shown that absorption spectra can be particularly useful in cases where conjugated double bonds are important. Evidence can be deduced with regard to the presence of cyclic or aromatic molecules in a given sample. The distillation of heat-polymerized methyl esters of the acids from a drying oil, yields residues which absorb ultra-violet light more strongly than the monomeric distillates. This increased absorption is evidence of either increased unsaturation or increased complexity of molecular structure. The corresponding decrease in iodine value and other chemical evidence makes ring formation the most acceptable explanation. The changes in the absorption spectra of linseed and tung oil on heat bodying are given, indicating that considerable amounts of unreacted acids are still

present in these oils as the gel point is approached. In the case of linseed oil there is a nett increase in the amount of conjugated acids present in the first stages of heat treatment, followed by a gradual decrease. H. E. T.

640.* Phase Equilibria in Hydrocarbon Systems : Propane–*n*-Pentane System. B. H. Sage and W. N. Lacey. *Industr. Engng Chem.*, 1940, **32** (7), 992.—Volumetric and phase behaviour of nine mixtures of propane and *n*-pentane have been measured throughout the two-phase region at temperatures above 130° F. The data obtained are used to construct graphs and tables showing compressibility factors, specific volumes, compositions of phases, and equilibrium constants. P. D.

641.* Nomographs for Correcting Volumes of Perfect Bases. J. G. Roof. *Industr. Engng Chem.*, 1940, **32** (7), 998.—Directions are given for the construction of two simple nomographs for correcting volumes of dry gases over small ranges of temperature (approximately 5°) and any range of pressure. J. W. H.

642.* P–V–T Relations of Propylene. W. E. Vaughan and N. R. Graves. *Industr. Engng Chem.*, 1940, **32** (9), 1252.—The P–V–T– relations of propylene have been measured over the pressure range 2–80 atms. and at temperatures from 0° to 300° C. The experimental technique is described, and the investigation covered the determination of all critical constants. J. W. H.

643.* Phase Equilibria in Hydrocarbon Systems. Methane–*n*-Butane System. B. H. Sage, R. A. Budenholzer, and W. N. Lacy. *Industr. Engng Chem.*, 1940, **32** (9), 1262.—The specific volumes of twenty-four mixtures of methane and *n*-butane were determined over the pressure range up to 3500 lb. per sq. in. and temperature range 70°–250° F. The results were interpolated to even values of pressure and temperature and are presented in tabular form. *iso*Thermal enthalpy coefficients are also derived for mixtures containing 0·60–1·00 weight fraction of methane. The partial thermodynamic properties of the two constituents are also given in tables. Further tables give the partial volumetric properties in the gas and liquid phases. Graphs are given showing the partial volumetric and thermodynamic properties over the concentration range at 160° F. P. D.

644.* Nomograph for the Clausius–Clapeyron Equation. C. L. Crawford. *Industr. Engng Chem.*, 1940, **32** (9), 1280.—A nomograph is presented enabling the latent heat to be estimated from a knowledge of the vapour pressure at two temperatures (one of which may be the B.P.), or the vapour pressure at any temperature may be estimated from latent heat and boiling-point data only. J. W. H.

645.* Nomograph for Paraffin-Wax Solubility in Petroleum Fractions. D. S. Davis. *Industr. Engng Chem.*, 1940, **32** (10), 1293.—The experimental data on the solubility of wax in petroleum fractions obtained by Berne-Allen and Work (*Industr. Engng Chem.*, 1938, **30**, 806) are presented in the form of a nomograph which is considerably more simple to use than the graphical presentation of the results given in these authors' paper. J. W. H.

646.* Oxidation of Aromatic Hydrocarbons. C. R. Downs. *Industr. Engng Chem.*, 1940, **32** (10), 1294.—Benzoic acid, anthraquinone, and its numerous derivatives produced in the United States is now manufactured almost exclusively from phthalic anhydride. The phthalic anhydride is prepared by catalytic oxidation of naphthalene, using vanadium oxide as the catalyst. Phthalic anhydride is also of great use in the manufacture of synthetic resins. The production of phthalic anhydride at the present time in the United States is approximately 70–75 million lb. per year, and there is no shortage of naphthalene if larger quantities of phthalic anhydride were required. The catalytic vapour-phase oxidation of naphthalene to phthalic anhydride has many important economic effects on other processes and raw materials. H. E. T.

647.* Solubility of Methane in *cyclo*Hexane. E. P. Schoch, A. E. Hoffman, and F. D. Mayfield. *Industr. Engng Chem.*, 1940, **32** (10), 1351.—Experimental procedure and results of the determination of the solubility of methane in *cyclo*hexane at pressures up to the critical pressure and at temperatures of 100°, 160°, and 220° F. are given. The specific volumes of the liquid phases, together with their compressibilities up to 6000 lb. per sq. in., are reported. J. W. H.

648. Velocity of Compressional Waves in Petroleum Fractions at Atmospheric and Elevated Pressures. R. Matteson and C. J. Vogt. *J. appl. Phys.*, October 1940, **11** (10), 658–665.—Velocities of compressional waves in thirty-seven petroleum fractions were measured at 100° F. and atmospheric pressure. The oils investigated ranged from light gas oils to viscous lubricating oils. Wave velocities were calculated from wave-length determinations made by means of a Hubbard ultrasonic interferometer used in conjunction with a quartz crystal ultrasonic wave-generator. Compressional waves in the oil were reflected from the face of a piston mounted on a micrometer screw, and the position of nodes was determined by the deflections of a galvanometer in the generator-plate circuit. The results of the measurements are essentially those corresponding to an infinite medium, since viscous drag and tube-wall expansion are negligible.

Curves are shown from which it is possible to estimate the velocity of compressional waves at 100° F. and atmospheric pressure if the specific gravity and kinematic viscosity are known. Velocity–temperature curves for a number of pure hydrocarbons are given to illustrate the effect of chemical composition.

Tests at elevated pressures up to 6000 lb./sq. in. and temperatures from 57° F. to 210° F. were made in a different apparatus. The passage of a pressure disturbance along a steel tube was measured by means of electromagnetic indicators coupled to a galvanometer-type oscillograph. The results of the tests made with the apparatus indicate that the more easily determined tests at atmospheric pressure can be reduced to the conditions found in diesel-engine fuel lines by the use of the Helmholz relation. The velocities encountered in the average injection system may vary as much as 25% through the range of operating conditions and oils used to-day, and this variation might easily be the cause of a change from satisfactory to unsatisfactory engine operation. J. G. W.

649. Flame Temperature. B. Lewis and G. v. Elbe. *J. appl. Phys.*, November 1940, **11** (11), 698–706.—The theoretical flame temperature corresponding to complete statistical equilibrium in the burned gas is distinguished from the experimental flame temperature measured by the gas-law equation and corresponding to equilibrium in the translational degrees of freedom. Experiments on fast flames in closed vessels show that the latter may be higher than the former, due to excitation lag in the internal, presumably vibrational, degrees of freedom.

The theory and technique of measuring flame temperatures by the line-reversal method, by the variation of resistance of wires, by thermocouples, and by the measurement of brightness and absorbtivity in the infra-red are described.

Methods of determining the temperature and emissivity of soot-forming luminous flames are given.

In industrial furnaces the differences between the theoretical and experimental temperatures should be negligible, but in internal-combustion engines excitation lag is likely to exist, but no experimental confirmation is available. J. G. W.

650. Improved Radiation Pyrometer. T. R. Harrison and W. H. Wannamaker. *Rev. Sci. Instrum.*, 1941, **12** (1), 20.—If a radiation pyrometer of conventional design is calibrated at a given ambient temperature, and the latter is then altered, the calibration is in error. The error may be decreased by an increase in the amount of heat conducted away from the hot junction. A mathematical analysis is presented, from which general conclusions were reached pointing to the possible methods of reducing the error. As a result an instrument with very greatly diminished error was designed. This is fully described and its operational characteristics given. P. D.

651.* Rapid Discharge of Gas from a Vessel into the Atmosphere. E. Giffen. *Engineering*, 1940, **150** (3892, 3893, and 3895), 134–136, 154–155, and 181–183.—A method

of calculating the rate of discharge of gas from a cylinder, based on the consideration of wave action, is described, and is applied to a typical problem. By taking the discharge over a series of time intervals, the pressure–time relation is built up and a value for the depression below atmospheric pressure at the end of discharge is obtained.

A second method, based on the assumption of uniform pressure in the vessel, is also given, and calculations are made to give a comparison with the first method. Little difference is shown between the results obtained by the two methods, and the latter, which is much simpler, may be regarded as giving a good idea of the actual time of discharge, and the rate of decrease of pressure. However, it is only by the former method that the depression at the end of discharge can be estimated, and in this respect it represents an advance on the latter, and approaches nearer to the true conditions. J. G. W.

652.* Copolymerization of Acetylene and Butylene in Silent Electric Discharges. A. D. Petrov and D. N. Andrev. *J. appl. Chem.* (*U.S.S.R.*), 1940, **13** (9), 1341–1347. Translated by A. A. Boehtlingk. *For. Petrol. Tech.*, January 1941, **9** (1), 1–12.—The product of joint polymerization of an equimolecular mixture of acetylene and butylene in silent electric discharges was found to be different from the polymerizates of acetylene and butylene alone. A characteristic peculiarity of the polymerizate is the presence in it of about 10% of acetylene hydrocarbons of the composition C_nH_{2n-2}, as well as the ability of about 70% of the hydrocarbons of the polymerizate to become converted into a rubber-like polymer as a result of auto-polymerization. B. M. H. T.

653.* Cracking Methane in an Electric Arc at Reduced Pressure. N. P. Bozhko. *J. appl. Chem.* (*U.S.S.R.*), 1939, **12**, 1816. Translated by A. A. Boehtlingk. *For. Petrol. Tech.*, January 1941, **9** (1), 13.—In the cracking of methane in the electric arc it has been shown that at sub-atmospheric pressure it is possible to obtain high concentrations of acetylene and to decompose more than 90% of methane at a cracking down to carbon of 11–13%. The separation of carbon takes place mainly in the piping, and not in the zone of the discharge. It is the result of the thermal decomposition of acetylene which is removed from the discharge at a fairly high temperature. The consumption of the energy in the cracking in the arc at a pressure of 80–50 mm. may be lowered to 11–12 Kw./M.^{3} of C_2H_2 at an acetylene concentration of 9–16% in the final gas. The consumption of energy increases to 16–17 Kw./M.^{3} of acetylene at a pressure of 30–35 mm., when an almost complete decomposition of methane takes place. B. M. H. T.

654.* Isomerization of Polymethylene under the Influence of Aluminium Chloride. M. B. Turova-Polyak and T. A. Slovokhotova. *J. Gen. Chem.* (*U.S.S.R.*), 1940, **10** (15), 1435–1438. Translated by A. A. Boehtlingk. *For. Petrol. Tech.*, January 1941, **9** (1), 33.—By the action of aluminium chloride on *iso*propyl*cyclo*pentane at 125–130° C. a mixture of hydrocarbons is obtained in a proportion of 87% by weight of the hydrocarbon used in the reaction. The mixture is composed of 87·7% hexamethylene, 9·4% pentamethylene, and 2·9% paraffin hydrocarbons. The hexamethylene hydrocarbons are composed of a mixture of *p*- and *m*-dimethyl*cyclo*hexanes. The structure of the side-chain of the *cyclo*pentane hydrocarbon does not affect the structure of the products of its isomerization. B. M. H. T.

655.* Separation of Pure Methane from Hydrocarbon Gas Mixtures by Means of Selective Absorption. Yu. G. Mamedaliev and A. Kuliev. *J. appl. Chem.* (*U.S.S.R.*), 1940, **13** (5), 738–742. Translated by A. A. Boehtlingk. *For. Petrol. Tech.*, February 1941, **9** (2), 53.—The selective adsorption of mixtures of gaseous saturated hydrocarbons composed of methane, ethane, propane, butanes and pentanes, was investigated by the dynamic method. The analysis of the discharging gases was carried out in an apparatus specially constructed for the purpose, by means of which a determination of the heavier hydrocarbon content could be carried out in a few minutes. The selective action of the adsorbent was found to increase with decrease in the velocity of the movement of the gas. At a velocity of 1·59 litres of gas per sq. centimetre of cross-section of adsorber per hour, ethane makes its appearance after the passage of 250 litres of gas per kilogram of activated carbon. On increasing the velocity up to

0·36 the volume of the separated pure methane is lowered to 200 litres. Of great importance is the ratio of the height of the layer of the adsorbent to its diameter. The selective action of the adsorbent increases with the increase of this ratio. The appearance of methane homologues is of the type of a sharp jump, and the moment of their appearance depends on the ratio of the components of the gas mixture, the speed of its flow, the ratio of the height of the adsorbent to its diameter, the quality of the adsorbent, and other conditions. Under the most favourable conditions, 1 kg. of activated charcoal removes higher homologues from about 300 litres of dry and 88 litres of wet gas. The separated methane contains in the first case 0·04% and in the second less than 0·2% of ethane. B. M. H. T.

Analysis and Testing.

656.* Method for Determining Total Chloride Content of Heavy Oils. W. A. Schulze, J. P. Lyon, Jr., and L. C. Morris. *Oil Gas J.*, 10.4.41, **39** (48), 40.—The commonly used methods for determining the chloride content of crude oils by analysing an aqueous extract will not determine the organic chlorine. The recommended procedure consists of (1) burning the oil sample mixed with pelleted chloride-free carbon-black, (2) absorbing the gaseous products in an alkaline solution to which is added the residue after combustion, (3) titrimetric determination of chloride in this solution.

The apparatus used is described and illustrated.

For a test about 13 ml. of carbon-black is placed in the combustion tube followed by 5 ml. oil. Another 10 ml. of carbon-black is added, followed by 5 ml. oil, this being repeated until the desired weight of sample has been added. The absorbers are filled with *N*-sodium bicarbonate solution. The combustion tube is gently heated to drive out lighter constituents, which are then burned and the residual mass ignited. The absorbent solution containing the residue of combustion is concentrated, made slightly acid with dilute HNO_3, and heated gently to expel CO_2 and SO_2. An excess of $AgNO_3$ is then added, the solution warmed to coagulate the AgCl, and filtered. The filtrate is titrated with 0·02N ammonium thiocyanate, using ferric alum as an indicator.

Results obtained with heavy oils containing known quantities of organic and inorganic chlorine compounds have indicated an absolute accuracy of $\pm 2{\cdot}5\%$ when a sample equivalent to 5–15 mg. of chlorine is analysed. D. L. S.

657. Conductivity of Insulating Oils under Alternating Stress. J. B. Whitehead and B. P. Kang. *J. appl. Physics*, 1940, **11** (9), 596.—Conductivity measurements were made on a sample of insulating oil as manufactured and after oxidation. The measurements were made under a voltage gradient of 20–80 volts per mil, and special arrangements were made to record the initial or short-time conductivity. The ratios of initial to final conductivities were in the range 3–5·5.

The dielectric loss under 60 cycle A.C. agreed with the loss computed as leakage loss due to the initial conductivity. P. D.

Motor Fuels.

658.* Use of Activated Glycerides for Stabilizing Gasoline. F. W. McCurry. *Oil Gas J.*, 12.12.40, **39** (31), 53.—This article is a report of part of a discussion on lubricants presented at the 1940 meeting of the A.P.I.

It shows how an activated glyceride is able to hold metallo-organic compounds in solution in gasoline and is also able to eliminate haze. Some fuels can be stabilized with as little as 1 part in 200,000 parts of gasoline, whilst others may require 1 : 40,000. D. L. S.

659. Recent Developments in the Production of Aviation Spirits. The Use of Safety Fuels. Anon. *Fuel*, 1940, **19** (9), 200.—Despite existing doubts regarding the degree of safety conferred by the use of high-flash-point fuels—*i.e.*, those with flash-points above 105° F.—certain interest continues to be shown in the development of the solid-injection-fuel system for spark-ignition engines and the multiplication of refining

and synthetic processes giving fuels of high-boiling range with satisfactory octane number. The present two possible types of high-octane safety fuel are: (1) an aromatic type prepared from selected crudes by distillation and solvent extraction, perhaps augmented by highly aromatic material from cracking or destructive hydrogenation processes; (2) a purely synthetic paraffinic type produced by the sulphuric-acid alkylation process from *iso*butane and olefinic refinery gases. Both types of fuel may readily be produced with an octane number of 88 or more, but even with considerable addition of tetraethyl lead 100 octane does not appear attainable in either case.

The use of safety fuels in aircraft engines as at present contemplated involves the adoption of solid injection, for which system several advantages are commonly claimed; on the other hand, there are possibilities of trouble arising when running light, and when starting, due to the washing of lubricant from cylinder walls, and to crankcase dilution. Fuel consumption would be slightly greater than with normal spirits, although evaporation losses would be negligible and vapour lock eliminated.

It would appear on the whole that the major advantages of safety fuels might be in the diminution of fire risk in ground installations. To take full advantage of their properties in aircraft engines unwarranted changes in design and methods of operation would be required. Considerably more investigation will be necessary for safety fuels to prove their outstanding advantages in aviation. E. J. C.

660.* Use of Lecithin in Gasoline. H. V. Rees, W. S. Quimby, and J. C. D. Oosterhout. *Oil Gas J.*, 14.11.40, **39** (27), 176. *Paper before Division of Refining, A.P.I., Chicago, Nov.* 1940.—A review is given of laboratory work and several years' refinery experience on the reduction of decolorization, haze, and deposit formation in gasolines exposed to sunlight after the addition of lecithin and on its effect on the corrosion of iron and galvanized-iron containers by gasolines. Lecithin—a phosphatide obtained from soya beans by hexane extraction—has been found to reduce cloud formation on exposure of gasoline to sunlight, the effect being more pronounced on cracked and leaded fuels than on straight run. It has no effect on octane rating, lead susceptibility, copper-dish gum contents, and on the colour of the base gasoline before dyeing and leading. Sweetening before steam distillation renders gasoline more susceptible to the inhibiting effects of lecithin. With some leaded gasolines combination of lecithin with strong gum inhibitors and commercial phenol greatly improves the sunlight stability from the standpoint of cloud formation and colour changes. Lecithin is also useful for stabilizing the increase in accelerated gum content of aviation gasolines on storage. Its general effect is maintained in dark storage. Engines which have used refinery produced lecithin-treated gasolines for several years showed no deleterious effects.

Storage tests for 1 year on leaded and unleaded gasolines in the absence and presence of water and with and without lecithin showed that: (1) in the absence of water no corrosion took place; (2) in the presence of water the leaded gasolines caused more corrosion than the unleaded gasoline, the presence of alkali or of 5–10 lb. of lecithin per 1000 bbl. considerably reducing the corrosion of both iron and galvanized iron. In these proportions lecithin considerably reduces the formation of zinc oxide and decolorization in galvanized containers with leaded aviation gasolines. Corrosion of aluminium fuel tank-bottoms by leaded aviation gasolines is very largely eliminated by the use of lecithin. The dosages required vary from 1 to 15 lb. per 1000 bbl. of gasoline, costing $0·0056 per bbl. C. L. G.

661.* The Octane-Number Race. H. D. Lord and K. V. Gopalam. *Petroleum*, Feb. 1941, **3** (2), 39.—Following a brief reference to the relationship between thermal efficiency and the compression ratio of an engine, the phenomenon and cause of knocking and methods of rating fuels are discussed. The trend of automobile development and the improvement in the anti-knock qualities of fuels, present methods of manufacturing improved aviation fuels, and possible and probable future aviation fuels are dealt with. C. L. G.

662. Patents on Motor Fuels. N.V. de Bataafsche Petroleum Maatschappij. E.P. 535,054, 27.3.41. Appl. 14.7.39.—Conversion of saturated hydrocarbons boiling below 200° C. into isomeric hydrocarbons—*e.g.*, butane into *iso*butane, pentane into

*iso*pentane, hexane into branched-chain hexanes, octane into branched-chain octanes, and mixtures of normal hydrocarbons or straight-run gasoline into mixtures containing branched or more highly branched hydrocarbons. Aluminium halides are employed as catalysts at temperatures not exceeding 200° C., and the formation of by-products is repressed by carrying out the reaction in the presence of hydrogen under a total operating pressure greater than atmospheric.

E. A. Ocon. E.P. 535,210, 2.4.41. Appl. 28.6.39. Manufacture of branched-chain aliphatic hydrocarbons from straight-chain aliphatic hydrocarbons occurring largely in natural gas and crude petroleums and from oxygenated derivatives of such hydrocarbons. The *iso*-aliphatic hydrocarbons so produced are suitable for use as high anti-knock motor fuels.

Etna Carburettor, Ltd. E.P. 535,358, 7.4.41. Appl. 3.1.40. Method of production of fuel and air mixtures from liquid fuels, for use in internal-combustion engines. Liquid fuel is passed under pressure to a chamber heated by the exhaust gases of the engine, and is therein converted into a fixed and safe gas, which is directed through a restricted outlet to a mixing chamber open to the atmosphere. A fuel-and-air mixture is therein formed for delivery to the engine.

N.V. de Bataafsche Petroleum Maatschappij. E.P. 535,394, 8.4.41. Appl. 9.10.39. Treatment of hydrocarbons in the liquid phase with metal halides, particularly in the isomerization of saturated hydrocarbons with straight or only slightly branched chains to hydrocarbons with branched or relatively highly branched chains. According to the invention, for example, *n*-butane can be converted into *iso*-butane, *n*-pentane into *iso*-pentane, etc., and saturated gasolines with relatively low anti-knock values into gasolines with relatively high anti-knock values.

Standard Oil Development Co. E.P. 535,398, 8.4.41. Appl. 17.10.39. Conversion of normally liquid straight-chain paraffin hydrocarbons into branched-chain paraffin hydrocarbons by subjecting the former to the action of a catalyst of the aluminium chloride type and an activator for the catalyst, in the presence of free hydrogen and a light paraffinic gas containing a substantial amount of propane.

E. A. Ocon. U.S.P. 2,235,329, 18.3.41. Appl. 7.2.38. Process for converting hydrocarbon oils into relatively low-boiling hydrocarbons suitable for use as motor fuel with negligible coke formation.

A. J. Van Peski. U.S.P. 2,235,466, 18.3.41. Appl. 6.6.38. Preparation of an improved anti-knock motor fuel consisting of a gasoline-type motor fuel and a small amount of a normally liquid mixture consisting of cupric methyl amino-methylene acetone and cupric ethyl amino-methylene acetone.

C. Ellis. U.S.P. 2,237,660, 8.4.41. Appl. 14.1.39. Production of an anti-knock motor fuel for high-compression spark-ignition engines. The fuel consists of a major proportion of gasoline hydrocarbons blended with a substantial anti-knock improving amount of an aliphatic mono-ester having two branched alkyl terminals and containing seven to twelve carbon atoms in the molecule, with oxygen present only in the ester linkage. H. B. M.

Gas, Diesel, and Fuel Oils.

663. Recent Developments in the Production of High-speed Diesel Fuels. M. E. Kelly. *Fuel*, 1940, **19** (10), 219.—Following a discussion in which he suggests possible causes for the lack of desirable standardization of diesel fuels, the author quotes American opinions as to power and economy characteristics of fuels for automotive service. It is concluded that the present trend of fuel quality in the U.S.A. appears to be towards volatile, highly paraffinic fuels necessarily having low specific gravity. It is suggested that heating value, ignition quality, and possibly fuel viscosity are the only important fuel properties affecting engine power and economy. It has been stated that the upper limit of fuel viscosity, which is fixed primarily by the filtering system, is about 175 secs. Redwood No. 1 at 100° F. As regards the lower limit, it has been suggested that the use of fuels of lower viscosity than 37 secs. Redwood

No. 1 at 100° F. necessitates additional maintenance of the fuel-injection system, but this has not yet been proved to be the case.

It is pointed out that ignition quality, measured as cetane number, in general increases with decreasing specific gravity, and authorities are quoted stating that there is a certain correlation between the cetane number and physical properties. While there is no proof that ignition quality is the single factor controlling combustion, if the cetane number is satisfactory the probable combustion course can be predicted with reasonable accuracy. The same authorities consider the combustion process in the high-speed diesel engine to be more critically affected by minor changes in inherent design than by improvements in fuels. The possible benefits of improvements in high-speed diesel fuels therefore appear small. In the U.S.A. in order to conserve certain types which also form motor-spirit cracking stock there will be every incentive to change to less volatile fuels when the volume of demand is greater. E. F. C.

664. Patents on Gas, Diesel, and Fuel Oils. Standard Oil Development Co. E.P. 535,401, 8.4.41. Appl. 25.10.39. Production of an improved fuel of the diesel type, which consists of a hydrocarbon base fuel to which has been added a small amount of an alkyl nitrate having at least 10 carbon atoms per molecule. The base fuel comprises a distillate having a boiling range between 450° and 650° F., an A.P.I. gravity between 30° and 45°, an aniline miscibility point above 140° F., a flash-point above 150° F., and a cetane number in the range 60–100.

E. W. Thiele. U.S.P. 2,234,207, 11.3.41. Appl. 19.10.39. Conversion of gas-oil cracking stock into gasoline and merchantable fuel oil. The oil stock is separated by the action of a selective solvent into a raffinate and an extract fraction; the raffinate fraction subjected to cracking; and the cracked products separated into heavy tar, cycle oil, gasoline, and gaseous hydrocarbon constituents. The cycle oil is thereafter recycled to the cracking operation and the viscosity of the tar reduced by combining therewith a sufficient amount of the extract fraction to produce the desired fuel oil.
H. B. M.

Lubricants and Lubrication.

665. Studies in Lubrication IX. The Effect of the Pressure Variation of Viscosity on the Lubrication of Plane Sliders. M. Muskat and H. H. Evinger. *J. appl. Phys.*, November 1940, **4** (11), 739–748.—The Reynolds theory is applied to the case of plane sliders or thrust bearings with lubricants the viscosities of which increase exponentially with pressure. The coefficient of friction, minimum film thickness, and oil-flow were calculated both for fixed-wedge angle and pivoted sliders. The effect of the viscosity variation with pressure is determined, and the analysis shows that in all cases there will be a limiting position of the pivot line of the slider or of the equivalent Sommerfeld variable at which the film pressures and frictional forces become infinite. Moreover, the maximum load per unit area that can be carried by such a system is equal to twice the reciprocal of the viscosity-pressure exponent.

Specific calculations give curves of coefficient of friction against load or Sommerfeld variable quite similar to those from experimental determinations. At high loads the friction coefficient curves split and follow the behaviour generally interpreted in terms of boundary lubrication. J. G. W.

666. Recent Developments in the Production of Lubricating Oils: the Use of Additives. M. E. Kelly. *Fuel*, 1940, **19**, 180.—References are given to papers on various types of additive agents incorporated in lubricating oils: pour-point depressors, anti-oxidants, anti-lacquers, viscosity-index improvers, oiliness-increase agents, substances which increase pressure at the film-rupture point, corrosion inhibitors, and detergent compounds to assist in removal of carbon. J. W. H.

667. Patents on Lubricants and Lubrication. R. Rosen. U.S.P. 2,234,581, 11.3.41. Appl. 30.9.37.—Preparation of a lubricant consisting of a major proportion of a hydrocarbon oil and a minor proportion of an organic boron compound, the latter containing at least one carbon–boron bond.

S. E. Jolly. U.S.P. 2,234,915, 11.3.41. Appl. 11.10.39. Addition of a minor percentage of a nitrile to lubricating oil. The nitrile has been derived from petroleum and halogenated and contains from 5% to 50% of the halogen.

A. J. Morway and J. C. Zimmer. U.S.P. 2,235,161, 18.3.41. Appl. 20.9.38. Preparation of a lubricant consisting of a sulphide of phosphorus and a mineral lubricating oil. The lubricant is capable of carrying heavy loads.

N. D. Williams. U.S.P. 2,235,860, 25.3.41. Appl. 19.10.38. Preparation of a halogenated extreme-pressure lubricant consisting of mineral lubricating oil and a compound selected from a particular group of halogenated ketones and halogenated esters.

T. Hasselstrom. U.S.P. 2,235,926, 25.3.41. Appl. 2.12.39. Preparation of a grease including as a setting agent the crude, non-crystalline, brownish, insoluble product obtained by treating a mixture of dehydrogenated and hydrogenated rosin with concentrated sulphuric acid under conditions which promote sulphonation and removing the sulphonic acid by aqueous extraction.

N. F. Toussaint. U.S.P. 2,236,120, 25.3.41. Appl. 17.1.39. Preparation of a lubricant for use in internal-combustion engines consisting of a major proportion of a petroleum lubricating oil and a small amount of nickel naphthenate.

M. A. Dietrich. U.S.P. 2,236,168, 25.3.41. Appl. 27.2.40. Preparation of a lubricant consisting of a major proportion of a viscous petroleum oil and a small proportion of an oil-soluble organic sulphonamide, devoid of free sulphuric acid and free sulphonic acid groups.

R. L. Humphreys. U.S.P. 2,237,526, 8.4.41. Appl. 12.12.34. Manufacture of a lubricating composition consisting of a lubricating oil and at least 0·5% by weight of benzothiazol tetrasulphide.

H. E. Ries. U.S.P. 2,237,632, 8.4.41. Appl. 25.5.38. Method of improving the lubricating properties of a hydrocarbon lubricating oil by incorporating therewith a small proportion of an alkylated triphenyl phosphate in which each alkyl group contains 10 or more carbon atoms.

L. W. McLennan. U.S.P. 2,237,682, 8.4.41. Appl. 24.8.35. Preparation of a grease consisting of a major proportion of mineral oil thickened with calcium soap in an amount sufficient to impart cup-grease consistency, and from 10% to 25% of an air-blown asphalt having a melting point (R and B) between 140° and 155° F. and a penetration at 77° F. between 30 and 40. H. B. M.

Special Products.

668. Patents on Special Products. British Thomson Houston Co., Ltd. E.P. 534,573, 11.3.41. Appl. 1.9.39. The invention is based on the discovery that highly chlorinated paraffin and paraffinic materials, such as paraffin wax and paraffin oil, when suitably prepared and purified, and in admixture with or dissolved in a stable liquid chlorinated benzene, are chemically stable and inert, and can be used without corrosive effects when in contact with metals in electric devices.

N.V. de Bataafsche Petroleum Maatschappij. E.P. 535,468, 9.4.41. Appl. 11.3.40. Production of colourless or light-coloured sulphonium compounds by reacting sulphuric acid or an aryl sulphonic acid ester of a primary aliphatic alcohol of low molecular weight with a mixture of thio-ethers, prepared from a mercaptan mixture originating from the refining of a mineral oil or mineral-oil product. H. B. M.

Detonation and Engines.

669.* Some Fallacies Concerning the Petrol Engine. W. T. David. *Engineer*, 1940, CLXX, 388–389.—It is thermodynamically desirable that the chemical energy of the charge in a spark-ignition engine should be wholly released—up to the limit imposed

by dissociation—by the time the peak pressure is reached. The common assumption that a sharply defined peak pressure indicates that the chemical energy has been fully released is disproved by the author:

(1) By comparing the actual rise of pressure after explosion with carefully calculated theoretical values in which allowance is made for heat loss after explosion. Several experimenters, including the author, have found that between 70% and 81% of the chemical energy of the charge was released by the time the peak pressure was reached. In a specially designed hemispherical combustion space of a gas engine the exceptional value of 90% was obtained.

(2) By comparing the expansion curve of an actual indicator diagram with a theoretically calculated adiabatic expansion curve drawn through a peak pressure of the actual indicator diagram. Since the actual expansion curve lies well above the theoretical curve in all cases examined, it is clear there is a continued evolution of heat during the expansion stroke.

The author stresses the importance, from the aspects of fuel economy, engine reliability and life, of the desirability of securing as perfect homogeneity as possible. He has previously shown imperfect mixing to be the cause of incomplete combustion of the charge at peak pressure, with attendant higher exhaust gas and valve temperatures.

In discussing the effect of normal fuel types on engine efficiency, the author shows that, contrary to some beliefs, even under non-detonating conditions differences up to 5% in efficiency may be expected from a given engine running on various fuels. In the case of gaseous fuels the efficiency may be expected to vary widely, according to their nature.

In conclusion, heat-loss distribution in high-speed engines during explosion and expansion is discussed and discrepancies between the work of well-known authorities are indicated. E. F. C.

670.* Cylinder-Liner Wear in Gas Engines. Anon. *Engineering*, 1940, **150** (3896), 216–217.—Information has been collected by the National Gas and Oil Engine Co., Ltd., in respect of cylinder-liner wear in two gas-engine installations manufactured by themselves. One consists of four 12-cylinder 1500-h.p. engines of the vertical type, there being six cranks with two cylinders in tandem to each crankpin. The cylinder diameter is 26 in., and the engines operate on blast-furnace gas as fuel. Two of the engines were started up in 1921 and two in 1924. The other installation dealt with comprises six 6-cylinder 600-h.p. engines running on producer-gas generated from wood. These engines, which are installed in the power-station of a South American gold-mine, have a cylinder diameter of 17 in. and a stroke of 21 in.; they have been at work for about 11 years, representing some 70,000 hours' running.

The average liner wear in the top cylinders of the four blast-furnace gas engines was 0·001 in. per 1000 hrs.' running, and the maximum allowable wear was fixed at 0·1 in. before relining was carried out. The average rate of wear in the bottom cylinders was less than half that in the top cylinders.

In the producer-gas engine installation, except in the case of two engines which also showed a wear of 0·001 in. per 1000 hrs., the average liner wear was rather lower at about 0·0007 in. per 1000 hrs.

Although new liners have been fitted to these engines, the original pistons are still in use. Piston-ring groove clearances measured on one engine after 70,000 hrs.' running showed the average groove wear to be 0·012 in., 0·007 in., and 0·005 in. for top, middle and bottom rings, respectively, and it is thus assumed that the pistons should be still quite good for a further 70,000 hrs.' running. E. F. C.

671.* Exhaust-Pipe Pressure Waves. L. J. Kastner. *Engineering*, 1940, **150** (3901), 301–303.—The theoretical expressions for the velocity of waves in pipes are discussed with reference to such factors as temperature, pipe diameter, frequency, and the effect of large amplitudes. Although very high velocities may occur near the source of disturbance, these have but little influence on the average velocity of propagation.

A method of calculating the initial pulse is given, but it is pointed out that this is laborious. A little experience allows the shape of the pulse to be guessed, or it may be obtained experimentally.

The formation of the pressure wave in the pipe is examined, and it is shown how it may be arranged to assist the charging of the engine. Various curves are given, and their use in estimating suitable exhaust-pipe lengths for two-stroke engines is described.
J. G. W.

672.* **Loss of Power in Petrol Engines Running on Producer Gas.** H. Heywood. *Engineering*, 1941, **151** (3915), 61–63.—It is shown that when a petrol engine is converted to use producer gas as fuel there is an unavoidable decrease in power of about 40–50% due to :

(1) The low calorific value of the gas-and-air mixture.
(2) Reduction in volume of products of combustion from the original charge volume.
(3) Reduced density of cylinder charge due to high gas temperature and/or pressure drop through the producer and filter.

This power loss may be reduced in the following ways :

(1) By increasing the compression ratio from the standard assumed value of 6·25 to 8·5, 15% more power may be obtained.
(2) By increasing the calorific value of the gas. It is shown that variations in gas quality can account for differences in power output of between 35% and 40%.
(3) By supercharging the gas–air mixture. With about 9 in. Hg. boost the power developed would be equal to that normally obtained on petrol.
(4) By the addition of petrol vapour to the mixture. This expedient is, however, regarded as only a temporary measure, and involves combustion difficulties, owing to air shortage at full throttle.

By using an entirely new engine of approximately double the capacity of the original petrol engine, comparable powers may obviously be obtained. E. F. C.

673. **Condenser-type High-speed Engine Indicator.** Louis C. Roess. *Rev. Sci. Instrum.*, June 1940, 11 (6), 183–195.—The basic principle involved in the indicator is the modulation of a high-frequency carrier wave by the capacity variations of a condenser-type microphone or pick-up. This element, which is screwed into an indicating hole in the engine cylinder, consists essentially of a stainless-steel shell rigidly supporting inside it a mica-insulated electrode. The lower end-plate of this forms a condenser with a diaphragm integral with the lower screwed end of the steel shell, an air gap of the order of 0·003–0·005 in. normally being used. The diaphragm thickness is chosen by compromising between sensitivity, which varies inversely as the thickness cubed, and fidelity of reproduction, which is mainly determined by the lowest natural frequency of the diaphragm. Practical values vary from 0·035 to 0·070 in., with natural frequencies from 50,000 to 100,000 cycles per second.

Problems usually associated with the condenser type of pick-up—viz. capacity changes produced by the motion of microphone parts other than the diaphragm and vibration effects of the pick-up-amplifier leads—have been successfully overcome ; the latter effect by the use of a special balancing circuit described in detail. Because of the sensitivity of the circuit, very little amplification is required to operate the cathode-ray oscillograph ; both pressure-time and rate of pressure change-time diagrams can be observed.

The sweep circuit used to provide the time axis on the screen is synchronized with the engine by means of the output of a magnetic pick-up actuated by a stud on the flywheel, whilst a similar pick-up operating a thyratron impulse circuit in conjunction with a series of flywheel studs produces a calibration of the time axis in crank-angle degrees.

Photography by individual engine cycles has been greatly facilitated by the use of an electron-beam intensifying circuit, which operates only at the correct instant and for the length of time to record the desired portion of the engine cycle.

Because of its wide frequency response, limited only by the elastic characteristics of the diaphragm, it is claimed that the indicator is particularly applicable to the study of knocking combustion. E. F. C.

674.* Car-Design Trends. T. A. Bissell. *J. Soc. aut. Engrs*, 1940, **47** (5), 445–460.—A survey of innovations and design features incorporated in the latest models of American passenger cars. Easier operation is a feature of several new cars, outstanding examples being the new Chrysler automatic 4-speed transmission, for use with fluid drive, and Packards new semi-automatic clutch. There is also a wider application of Oldsmobile Hydra-Matic drive. The only completely new car is the Nash Ambassador 600. The V. 16 Cardillac, Lincoln V.12, Ford V. 8, 60, and the La Salle have been discontinued. Buicks "compound carburetion" is one of the most important 1941 innovations, employing two dual carburettors, one of which operates only after the throttle of the other is opened about half-way. Greater fuel economy and power output are claimed. Practically all engines have been stepped up in power output, and compression ratios are still definitely increasing to take full advantage of the higher anti-knock properties of available fuels; ratios of 7–1 being used on the Buick 60, 70, and 90, and 7·25–1 on the Cardillac V. 8 and the Hudson 6-cylinder "L" head engines. C. H. S.

675.* Performance of Modern Aircraft Diesels. Paul H. Wilkinson. *J. Soc. aut. Engrs*, 1940, **47** (5), 474–479.—This paper reviews the development work on aircraft diesel engines which was in progress just prior to the war in Germany, France, Great Britain, and the U.S.A. Descriptions and some details of performance of several engines are given, most of which were experimental models. These engines include the latest German Junkers Jumo, B.M.W.-Lanova; the French Clerget; and the American Guiberson, and N.A.C.A. developments. C. H. S.

676.* Wear-resistant Coatings of Diesel Cylinder Liners. J. E. Jackson. *J. Soc. aut. Engrs*, 1941, **48** (1), 28–32.—This paper discusses the influence of chemical surfacing on the running-in of diesel liners.

Photomicrographs illustrate the condition of the liner surface after finish-honing before and after running-in, and the alteration in the surface before and after running-in produced by treating the surface in a concentrated water solution of sodium hydroxide and a small amount of sulphur. The process described is known as the "Surfide Process," and was developed by the Standard Oil Co. of California.

The process is one of etching, and any free ferrite at the bore surface is etched from the matrix. The important surface metal to be removed by the etching is the strain-hardened metal formed on the surface by honing. The etching process produces a matt surface which retains and spreads the lubricating oil and gives a greater degree of safety during the initial period of running-in. The coating formed by the process consists of ferrous oxide and ferrous sulphide tightly bonded to the unetched underlayer of iron. C. H. S.

677.* The C.U.E. Co-operative Universal Engine for Aviation Single-Cylinder Research. A. W. Pope, Jr. *J. Soc. aut. Engrs*, 1941, **48** (1), 33–40.—This article describes and illustrates the C.U.E. engine which was first developed for aero-engine spark-plug research and was first displayed at a meeting of the S.A.E. in 1937. The original design did not cater for the requirements of the petroleum industry, which was interested primarily in lubricating oil and fuel tests. After completing five designs, a combination was developed which appeared to meet all requirements, and fifteen of this latest type have been completed, and a further fifteen are now on order. The detailed description covers the major features in the design, including the balancing system; main roller bearings; the crank chamber; lubrication system; crankcase seal; temperature control; accessory drives; crankshaft; conn. rod; dynamometer coupling; reverse rotation; and fuel-injection system.

One of the main features of the engine is the balancing system which is contained in a sub-base entirely separate from the crank chamber, which remains clean and smooth, and the balancing system is thus quite separate and independent from the main engine-lubrication system. C. H. S.

678.* Bearing Metals and their Suitability for Modern Requirements. M. Melhuish. *J. Inst. aut. Engrs*, 1940, **9** (1), 1–12.—High-grade tin-base white metals which have been almost exclusively used for internal-combustion engine bearings until com-

paratively recently are now being supplanted by bearings of other materials. The author lists eight groups of bearing alloys in use at the present time and reviews the properties of each group. High-grade tin-base white metal has many advantages over other materials if the alloy is selected to suit the duty it has to perform. It has high anti-frictional properties, the property of bedding down to its shaft, and if short of oil will flow and give greater clearance. The present problem seems to be to develop a bearing material which, whilst retaining the advantages of a high-grade tin-base babbitt, will stand up to the heavy pounding loads which bearings are now called upon to withstand. C. H. S.

Coal and Shale.

679.* Oil Shales, Torbanites, their Allies and Some of their Problems. G. W. Himus. *Petroleum*, April 1941, **4** (1), 9.—There has so far been little fundamental work carried out on the chemical nature of the organic and inorganic matter present in shale, most of the investigation work relating to extraction and refining of the oils. The present discussion covers the work done and in hand on the determination of the kerogen content and its chemical composition, microscopic examination of the shale to indicate the origin of the kerogen-forming material, determination of the nature of the inorganic matter and of the relation of the kerogen to the mineral matter.

Determination of the ash of shale by combustion (and hence of the kerogen by loss) is rendered difficult by the presence of hydrated minerals and by their decomposition on heating. Removal of ash is best effected by treatment with dilute HCl followed by dilute HF, although this is not complete, about 1% of ferric oxide being left, pointing to the presence of ferro-organic compounds in the kerogen. After ash removal, ultimate analyses can be carried out. Microscopic examination of oil shale generally reveals macerated plant debris, seldom recognizable spores or algae, some, however, showing animal remains. Kerogen is believed to be mainly of vegetable origin, in evidence of which it has been shown that higher yields on carbonization are given by cannel coals containing higher proportions of algae. In some respects (*e.g.*, behaviour with alkaline $KMnO_4$) kerogen appears to be chemically allied to coal, although Esthonian kukersite appears to be from a different source, or produced under different conditions. The inorganic matter present varies widely from the Esthonian limestone to the fine siliceous silt of Newnes (N.S.W.), and to a large extent is not combined with kerogen, although a small part, so far impossible to separate, may be combined.

A petrological classification has been suggested (A. L. Down, *J. Inst. Petrol.*, 1940, **26** (201), 329) covering torbanites, boghead, and cannel coals, suggesting their relationship to the coals of the peat to anthracite series. This is based on the nature of the organic matter, quantity, and nature of the inorganic matter, and the structure of the rock. C. L. G.

Economics and Statistics.

680.* World Crude Production up 3·33%. *World Petrol.*, February 1941, **12** (2), 19–21.—In 1940 U.S.A. produced 1352 million barrels of oil, 6·83% more than in 1939. This was 63% of the world total. The rest of the world gave 794 million barrels, 2·11% less than in 1939. As compared with 1939, decreases in production during 1940 took place in Venezuela (10·21%), Iran, Netherland India (2·02%), Rumania (5·88%), and Iraq (16·45%), whilst there were rises in the U.S.S.R., Colombia (18·28%), Argentina (9·38%), Canada (14·27%), Trinidad (4·92%), and Egypt (31·47%).

Detailed figures are given by months and years for the more important producing countries. G. D. H.

681.* Economic Aspects of Hydrogenation Process. L. A. Stengel and R. N. Shreve. *Industr. Engng Chem.*, 1940, **32** (9), 1212.—The economic aspects of the hydrogenation process as applied to the manufacture of cheap commercial products is outlined. H. E. T.

BOOK REVIEW.

The Physics and Chemistry of Surfaces. By N. K. Adam. Pp. x + 402. 2nd Edition, O.U. Press, 1938. Price 22*s*. 6*d*.

This second edition of Professor Adam's book follows essentially the plan of the first, except for the omission of the chapter on the properties of molecules as deduced from methods other than those of surface chemistry, and the inclusion of one dealing with electrical phenomena at interfaces. In view of the enormous growth of the subject since the first edition in 1930, it has very wisely been largely rewritten.

Beginning with a short introductory chapter on the fundamental properties of liquid surfaces and the molecular interpretation of surface tension, he then deals very comprehensively with insoluble films on liquids. This is one of the best sections, as might be anticipated from his intimate association with this particular field, and shows an excellent balance in discussing the work of his own and other schools. After outlining the historical development, the experimental technique and types of monolayers encountered are discussed at some length. Mention is made of the large number of diverse problems for which this technique can be employed, such as structure determination for complex organic molecules, and chemical reactions at interfaces.

From insoluble monolayers we are led naturally to adsorbed films at the gas/liquid and liquid/liquid interfaces, including the thermodynamical proof and experimental test of the Gibbs adsorption isotherm. The behaviour of surface films in emulsification, a question of great interest to the petroleum technologist, and one which has been much to the fore recently, concludes this section.

Turning now to solid surfaces, an excellent account is given of their general properties, such as surface structure, contact angles, and work of adhesion to liquids which bear so directly on the flotation method of mineral separation, and emulsification by solid powders. This leads up to a discussion of the spreading of liquids and the mechanism of lubrication by boundary films. The catalytic and adsorptive powers of solid surfaces are well discussed in the light of modern concepts, although in a rather condensed fashion.

The general review of electrical phenomena at interfaces gives a clear discussion of the definition and origin of electrical potential differences, of the rôle of surface films in contact and electrode potentials, and of the ζ potential and electrokinetic phenomena. The book concludes with a useful chapter on the methods of measuring surface tension.

By restricting the details and more controversial points to small type, the author has provided a very readable treatment for the new-comer to this field. At the same time its critical treatment and comprehensive bibliography make it invaluable to all interested in this large and rapidly growing branch of physical chemistry.

A. E. Alexander.

BOOK RECEIVED.

Aeroplane Fuel and Oil Systems. Editors: E. Molloy and E. W. Knott. Pp. vi + 124. Illustrations 103. George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Price 6*s*.

This book deals with the inspection and maintenance of fuel and oil systems from the point of view of the aircraftsman and ground engineer. After a detailed survey of present-day fuel-supply systems, including an account of the general arrangement of tanks, pipe-lines, and control cocks, and of important accessories such as fuel-tank contents gauges, some typical examples of fuel and oil systems of both British and American aircraft are dealt with. In particular may be mentioned the Westland "Lysander," the Bristol "Blenheim," and the North American "16–3." A section is devoted to the testing of aeroplane fuel, the following most important tests being described: gravity, volatility, knock-rating, gum content, sulphur content, and vapour pressure. This is followed by instructions relating to the installation and maintenance of fuel and oil pipe-lines. Some notes on the testing of these lines are also included, together with practical notes on the de Haviland A.C. fuel pump, the Amal dual fuel pump, and the Standard Gipsy VI oil pump and their assembling.

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Geology and Development.

682.* Major Tectonic Provinces of Southern Oklahoma and their Relation to Oil and Gas Fields. E. A. Paschel. *Bull. Amer. Ass. Petrol. Geol.*, January 1941, **25**, 1–22.—Southern Oklahoma and adjoining areas are divided into five tectonic provinces, which, from east to west, are the Ouachita Mountains province, the Arkansas Valley geosyncline, the Hunton–Tishomingo uplift, the Andarko–Ardmore geosyncline, and the Amarillo–Wichita–Red River uplift. One is considered a part of the Appalachian–Ouachita–Marathon homogeneous mobile belt which extends across the Continent from Eastern Oklahoma; the other four are regarded as having the features of a heterogeneous mobile belt and are treated by the author as two "uplifts" and two "geosynclines," being compared with similar provinces in California. Evidence is offered to show that the Andarko–Ardmore geosyncline has been compressed or squeezed between the Hunton–Tishomingo uplift to the north-east and the Amarillo–Wichita–Red River uplift to the south-west. The local structures within the "geosynclines" are regarded as having been formed primarily by compression, whereas those on the "uplifts" are regarded as having been formed by "vertical uplift." Local structures of the two uplift provinces are considered as having possibilities of more prolific oil production than those within the geosynclines. Boundary and topographic maps are given, and it is considered that with the improved drilling now available the Ordovician beds at 10,000 ft. will prove profitable for development.

R. J. W.

638.* Traverse of Upper des Moines and Lower Missouri Series from Jackson County, Missouri, to Appanoose County, Iowa. L. M. Cline. *Bull. Amer. Ass. Petrol. Geol.*, January 1941, **25**, 23–72.—A summarization, carried out for the Iowa Geological Survey Department, of a traverse of the Pennsylvanian upper Des Moines and lower Missouri series made along the strike from near Kansas City, Missouri, to Appanoose County, Iowa, an outcrop distance of 180–200 miles, in order to correlate the hitherto unknown Iowa section of the Des Moines series with that of West Central Missouri. The work has in general substantiated previous work of the Missouri survey, and correlated for the first time some of the higher Des Moines Beds in the areas surveyed. Eleven generalized columnar sections are described, and show regional variations in lithology and thickness. Further work in the same series from the south and west area of Kansas City into South-eastern Kansas is still required to tie up more exactly the status of Blackjack Creek, Houx, Higginsville, Myrick Station, Worland, and Exline Limestones. The Ardmore, which is the most important limestone in the Cherokee group, and, despite its thinness, has remarkable distribution from the vicinity of Tielsa, Oklahoma, to Guthrie County, Iowa, and throughout the area, is a valuable marker where persistent and diagnostic units are generally lacking.

R. J. W.

684.* Position of San Andres Group, West Texas and New Mexico. F. E. Lowis. *Bull. Amer. Ass. Petrol. Geol.*, January 1941, **25**, 73–103.—The result of the study of this wide area has led the author to conclude that the San Andres group should be placed in the Guadalupe series instead of the Leonard series. His correlations were supplemented by palæontologic information. Stereograms were made of a wide area of the South Permian basin to gain a regional perspective of the Upper Permian stratigraphy. Certain major structural features were recognized and were controlling factors in Permian deposition, and the stratigraphic phenomena of the Permian basin are related directly to lateral gradation. Surface studies and subsurface work reveal that, as a result of this gradation, many of the facies are time equivalents, unconformities being found the best time-markers because of the changing facies. The stereograms as used were on blue-paper prints in three sheets of 72 × 42 in., 48 × 40 in., and 32 × 20 in., respectively. Vertical scale 1 in. = 1000 ft., the price being $4.25 the set.

R. J. W.

685.* Edna Gas Field, Jackson County, Texas. M. M. Kornfield and C. R. Steinberger. *Bull. Amer. Ass. Petrol. Geol.*, January 1941, **25**, 104–119).—This gas-field was dis-

covered in 1919 by means of surface geology, and is 7 miles north-west of the town of Edna, Jackson County, Texas, adjacent to the west bank of the River Lavaca, and in the area which includes the lakes locally known as the Horseshoe, Alligator, and Blackberry. In 1909 gas seepages were noted along the river near the present field, and these, together with the topographic features, suggested the existence of oil or gas. Following a report written by S. G. Drushel of Edna in 1919, the first well was drilled in 1921 to a depth of 2670 ft., where it blew out and the hole lost. A second hole was drilled 125 ft. east to a depth of 4019 ft., when a blow-out junked the hole. Further drilling in 1926 established a commercial gas-well in a sand at 2650 ft. The well was located 1200 ft. to the west of the other two wells, and although lasting only a few months (the gas being piped to Houston), it established the existence of gas in commercial quantities. Further drilling was carried out, and between 1919 and 1932 fifteen wells were drilled to gas sands varying from 2600 to 4100 ft. in depth, eight of which produced gas; the others failed because of blow-outs, etc. A well was drilled in the neighbourhood to 6425 ft., but ran into heaving shale, and was plugged back and completed at 5367 ft., where it sprayed 5 brl./day of 39° oil. Further wells were drilled to 7146–7155 ft., but heaving shale caused fishing jobs and abandonment as oil-producers; gas was obtained from 4637 to 4650 ft. by perforating casing. The sand locally was known as Rogers sand. A well costs about $25,000. 80–100 ft. of 16-in. conductor pipe is set, 1000 ft. of 10¾ in. to shut off artesian water sands and production string, 5–7-in. casing to 2–2½ in. tubing being used with Christmas tree connections tested 6000 lb.; wells produce through a 500-lb. separator. A tank of 65–250 brl. is erected to save the small amount of condensate produced with the gas, producing pressures being 1875 lb. on tubing and 1925 lb. on casing through ¼-in. chokes; open flow 32 million cu. ft. of gas daily. The Houston Gulf Gas Co. contract for the gas at a price of 5 cents per 1000 cu. ft. Condensate is sold for tractor fuel. Sands have been logged at the following depths: 2600, 3570, 3850, 3955, 4105, 4640, 4750, 4960, 5360, and 5780 ft. Sands above 4200 ft. were developed during the early history of the field within a restricted area, but since 1936 the lower sands were produced and the area extended. It is believed that careful and extensive coring, supported by electrical well logging, will add a number of producing gas-sands and possibly oil-sands uncovered in the section now considered gas-bearing only. Life of individual wells should lengthen with improved completion methods and restricted flowing rates of the gas as compared with heavy unrestricted withdrawals in the older wells. R. J. W.

686.* Geology of Wind River Mountains, Wyoming. E. B. Branson and C. C. Branson. *Bull. Amer. Ass. Petrol. Geol.*, January 1941, **25**, 120–151.—The paper is a summary of research to date, with preliminary conclusions, which for several years have been planned by the authors, on the geology of the Wind River Mountains. The mountains are eroded from a north-west to south-east trending anticline, and lie entirely within the boundaries of Freemont County, Wyoming, the range being 150 miles long and about 40 miles wide. Maximum elevation is 13,800 ft., and on the east it rises above a general level of approximately 5000 ft. and 7000 ft. on the west, the largest town on the east side being Lander, and Pinedale on the west side. Wind River and its tributaries drain the north-east side and Green River the south-west side, whilst Sweetwater River drains the south end and part of the south-west side. The range consists of a core of pre-Cambrian granodirite and metamorphics on which are developed the higher parts of the range and the glaciated peaks. Palæozoic sediments form foothills on the north-east side and some resistant beds support long dip slopes to the plains. Mesozoic sediments underlie hogbacks and valleys paralleling the axis of the range. Dips of the sediments on the north-east flank range from 10° to 15°, covering Cambrian to late Cretaceous in age, only Silurian being absent. Eocene, Oligocene, Pliocene, and Pleistocene overlap older formations in some places. On the east side a series of anticlines parallels the main range about 25 miles from the summit. Anticlines on the east side are affected by minor faults, as is also the main ridge, and the pattern of the lakes indicates much faulting in the pre-Cambrian core. The main uplift and folding of the range came at the close of the Mesozoic, but minor uplifts occurred during the Cenozoic. These uplifts were probably irregular, as indicated by the absence of Ordovician and Devonian strata

at the south end and the pinching-out north of the range of the Tensleep, Phosphoria, and Chugwater formations.

The Lander Sandstone, at the base of the Ordovician, on the south end of the Wind River mountains, is absent at the north end and thickens to 80 ft. or more on the east side of Big Han Mountains.

Glaciation and peneplanation are worthy of fuller discussion, and the development of drainage lines east of the range requires fuller treatment than could be given in this paper.

Known oil-bearing formations on the east flank are: Madison, Tensleep, Phosphoria, Dinwoody, Sundance, Dakota, Mowry, and Frontier.

An areal geology map of the Wind River Mountains is given, in addition to a columnar section of the formations exposed, and formation names and various cross-sections. R. J. W.

687.* New Source for Sodium Sulphate in New Mexico. W. B. Lang. *Bull. Amer. Ass. Petrol. Geol.*, January 1941, **25**, 152–150.—Sodium sulphate-bearing brines have been discovered west of the Pecos River in south-east New Mexico within a short distance of the potash mines at Carlsbad. The brines are found in the Castile formation, where weathering has altered the anhydrite, and are probably the accumulations of the dense derivatives of percolating ground water through gravity differences retained in traps which temporarily at least preserve these concentrations from flushing by normal ground-water circulation. These brines are therefore considered as residual accumulations by differential gravity, a process relatively unique in the concentration of economic mineral matter in a dissolved form. The materials essential to the formation of such a brine are dolomite and gypsum with contained accessories, chief among which is halite, the place of lodgment of the brines being at or near (above) the surface of alteration of anhydrite in the Castile formation to Gypsum, where the surface is not more than 100–300 ft. below ground surface. If sufficient reserves can be located there is promise for commercial development. A map with a diagrammatic cross-section is given of the area concerned, and the paper also summarizes sodium sulphate production in other south-western States. R. J. W.

688.* Estimating Oil Reserves. F. H. Lahee. *Bull. Amer. Ass. Petrol. Geol.*, January 1941, **25**, 164–166.—The author stresses the importance of estimators stating by which method they have reached their figures, prior to publication of same. Estimates, he states, should be made by either the "probable area method" or the "proved area method." The former is the one often applied in calculating reserves on incompletely developed properties; the latter, which is conservative and relatively safe from large errors, is more often applied to proved areas, although with reasonably active wildcatting and development it is likely to show larger increments in reserves through extension of developed territory. Oil reserves may be figured:

(*a*) By the old method of decline curves;

(*b*) By multiplying together a number of factors previously studied and carefully measured, such as porosity, permeability, sand thickness, areal content, and recovery factor;

(*c*) By detailed analysis of production history, including data on gas-oil ratios, bottom-hole pressures, etc., and projection of this history into the future.

Whilst there may be room for considerable difference in the figures and estimates used, once the basis figures are agreed on there is a fair degree of similarity between the results obtained by different workers. R. J. W.

689.* Miocene of Caliente Range and Environs, California. J. E. Eaton, U. S. Grant, H. B. Allen. *Bull. Amer. Ass. Petrol. Geol.*, February 1941, **25**, 193–262.—An exhaustive paper with maps, sketches, and many photographs, including plates of the various faunas to be found. Caliente range and environs is considered to furnish what is believed to be the best Triocene record for California. Approximately 180 molluscans and echinoderm faunas, representing forty-seven nearly consecutive horizons, from that of Turritella inezana var. hoffmani upward to well above that

of Astrodapsis tumidus, have been obtained from a Miocene succession locally about 13,800 ft. in thickness.

The district lies at the junction of the three largest Miocene provinces of the State, linking their histories. A long, narrow, and deep upper Oligocene and Miocene trough about 300 miles in length and 20 in width, apparently extending from the Santa Cruz region south-east to Caliente Range, is the area the authors have discussed. Evidence obtained in Caliente Range and environs, in combination with state-wide data, suggests the history as follows :—

In *the lower Oligocene* California appears to have been completely emergent, with continental deposits being locally laid down near the present coast.

In *the upper Oligocene* the sea invaded the State as a narrow inlet occupying the newly initiated Caliente trough, continental deposition continuing in most former areas of that nature. The marine Miocene of California is a transgressive series, conformation basinward, but revealing strandward the occurrence of two oscillations which respectively inaugurate and divide its upper third, comprising three nearly equal major natural divisions, the Vaqueros (Lower Miocene), Temblor (Middle Miocene), and Monterey (Upper Miocene). Each of these has a more or less distinctive epeirogenic history, fauna, and average physical aspect. The sea transgressed during both Lower Miocene and Middle Miocene periods, with some regression during the latter period. It advanced once again widely during early Upper Miocene time, and reached its widest extent during this epoch. Progressively cooler waters are recorded during the Miocene series, the earlier tropical fauna being replaced by subtropical fauna with slightly hardier fauna at a later period. Each fauna changed relatively slowly during its stage, with hardier forms with the cooler waters, the Miocene series of California being divided into approximately equal thirds as regards major physical and coincident faunal incidents. Wide regression, resulting in complete emergence of California, separates the Miocene series from the markedly different and more restricted Pliocene series. The authors state that, except for parts of the Bilter Creek area, their field-work over twelve, seven, and three years, respectively, represents only a rapid reconnaissance made a few days at a time, but they regard this as providing preliminary framework for future investigation. R. J. W.

690.* Micropalæontology and Stratigraphy of a Deep Well at Niceville, Okaloosa County, Florida. R. Hendee Smith. *Bull. Amer. Ass. Petrol. Geol.*, February 1941, **25**, 263–286.—A water-well was drilled at Niceville to a depth of 524 ft. on April 1939, cuttings were taken approximately every 10 ft. and saved and carefully examined, thus enabling the author to establish some dip and strike control of the formations, and giving the first occurrences of some typical forms in the column where previously in the Upper and Middle Miocene sections considerable doubt had existed as to the thicknesses and depth of the beds and ranges of many of the microfossils. Formerly, owing to the rarity and scattered nature of good outcrops in Western Florida, stratigraphic work had been based almost entirely on palæontology, little attempt being made to ascertain thickness and amounts of dip. A standard section for the Middle Miocene of the Gulf Coast had previously been set up by two geologists, largely from outcrops in the area. The present work serves as a useful point of departure for correlation of wells in other parts of the Gulf Coast, as it aids in establishing the relative position of points in the palæontological time scale previously known only from inferential evidence. Map cross-section and charts are given. R. J. W.

691.* Pre-Cambrian Zeolite–Opal Sediments in Wichita Mountains, Oklahoma. C. A. Merritt and W. E. Ham. *Bull. Amer. Ass. Petrol. Geol.*, February 1941, **25**, 287–299.—The Wichita Mountains are located in south-western Oklahoma, principally in the counties of Kiowa and Comanche. The mountain system forms a physiographic unit of irregular peaks and low knobs with a maximum relief of about 1000 ft. The width is nowhere more than 28 miles and the extent some 65 miles to north-west and south-east, the peaks being separated by flat valleys or plains. The Wichita Mountain igneous rocks are Pre-Cambrian in age, and are composed chiefly of granophyres and gabbro-anorthosite. Rocks of a unique type have recently been discovered, composed principally of zeolites and opal, with variable amounts of dolomite and calcite, occurring as four scattered outcrops in Kiowa County. They appear to be

stratified and to have a maximum thickness of 47 ft., and are given the name of "Tapoe Creek." Evidence is given to show that the zeolites and opal have formed by the alteration of a sediment which was essentially an anorthosite-graywacke with some beds containing dolomite and perhaps limestone. The zeolites, chiefly natrolite, and the opal are secondary and partly diagenetic. R. J. W.

692.* La Rosa Field, Refugio County, Texas. B. Fisher. *Bull. Amer. Ass. Petrol. Geol.*, February 1941, **25**, 300–317.—This paper described the La Rosa field, discovered in 1938 as a result of geophysical work preceded by detailed surface mapping. The field is located in the southern part of Refugio County in the lower Gulf Coastal region of Texas. It is found in the so-called Frio trend, which is characterized by a maximum development of the sands on the Frio formation which shale out within short distances both up and down the dip. Most of the fields along this trend are very prolific and produce an excellent grade of crude oil. The use of electrical logs and careful coring have made the interpretation of structural conditions a relatively simple problem, whilst core analysis has provided valuable information concerning characteristics of the oil-sands. The reflection seismograph is given credit for the field's discovery. In all, some seventy-two oil-wells are producing from six separate sands, ranging in depth from 5400 to 6300 ft.; there are also six gas-wells completed in three different gas-sands. The 5900 ft. or discovery sand is clean, coarse-grained sand from 80 to 100 ft. thick and containing a maximum oil column of 30 ft., with a gas-cap, 25 ft. thick, on top. Sand averages 32 porosity and permeability 2000 milli-darcys. Ultimate recovery from this sand is indicated to be 975 brl./ft. Gas-oil ratio averages 500 cu. ft. gas per brl. oil produced which has a 42° A.P.I. gravity. R. J. W.

693.* Future of Field Geology. R. Dana Russell. *Bull. Amer. Ass. Petrol. Geol.*, February 1941, **25**, 324–326.—The author refers to a discussion published in the August 1940 number of the *Bulletin* in which leading geologists expressed the opinion that field geology as a technique for the discovery of oil-fields has not only passed its peak, but has practically exhausted its usefulness, except in foreign work. The author challenges this conclusion, and wonders whether the decline may not be ascribed to other factors, and stresses the value of careful surface mapping, illustrating this by enumerating fourteen areas where oil and (or) gas occurs. In only two can discovery be ascribed to surface geology alone, with surface indications aiding in the discovery of six others, but all could have been found by surface mapping. He also mentions Mississippi, which has been covered several times by geophysical surveys, yet it remained to a surface geologist to discover the first oil-field of this State. In conclusion the author's complaint is against the implication that field methods are no longer useful as a means of finding oil except in unknown foreign areas. Surface mapping, being by far the cheapest of exploration methods, should not be abandoned in favour of more expensive techniques until its possibilities have been exhausted. R. J. W.

694.* Upper Paleozoic of Western Australia. Correlation and Palæogeography. C. Teichert. *Bull. Amer. Ass. Petrol. Geol.*, March 1941, **25**, 371–415.—This paper was originally presented in January 1939 to the Geological Section of the Australian and New Zealand Association for the Advancement of Science. Further field-work carried out during 1939 and 1940 has rendered it necessary for the author to thoroughly revise and alter his previous presentation.

The paper deals with those rocks in Western Australia which were—as elsewhere on the Continent—until recently classified as Permo-Carboniferous. There has been a growing tendency in recent years to include these rocks unrestrictedly in the Permian, and in a later section of the paper the author discusses whether this is justifiable. The strata and their fossils are described in broad outline, and a correlation is suggested for the three important districts of Western Australia: Irwin River, North-west Division, and West Kimberley Division, which are compared with those of Eastern Australia, particularly of New South Wales, and it is indicated that the general succession of the Hunter River area in New South Wales can be recognized in West Australia—namely, Lower Marine–Lower Coal Measures–Upper

Marine. A physiographic map of Western Australia and a sketch-map of same showing the distribution of outcrops of Upper Palæozoic rocks, etc., together with an extensive bibliography, are included. R. J. W.

695.* Some Problems of Appalachian Structure. R. E. Sherrill. *Bull. Amer. Ass. Petrol. Geol.*, March 1941, **25**, 416–423.—The Applachian foreland is a broad, gentle, spoon-shaped synclinorium, the lowest part of which is in northern West Virginia and lies north and west of a closely folded and faulted mountain zone. Search for oil and gas production from deeper formations has emphasized the importance of a better understanding of the structure of this area. In his paper the author stresses the structural complexity of the Appalachian foreland, mentions some of the problems involved, and considers the origin of the folds, including direction of stress and mechanics of the folding, effects of rotational stresses, date of folding. These problems are, he states, not limited to the foreland, but are part of their entire concept of mountain deformation. Foreland problems having received scant attention in the numerous theories of orgeny, he considers that further geophysical, well record, and general stratigraphic data are needed in working towards a solution of these problems. Also important are the accumulation, correlation, and interpretation of data on the joints, local faults, and areas of exceptionally steep surface dips, it being necessary that each structure and problem be regarded as part of a large regional picture into which it must fit. R. J. W.

696.* Silurian Production, Shipley Field, Ward County, Texas. C. P. Cordry and M. E. Upson. *Bull. Amer. Ass. Petrol. Geol.*, March 1941, **25**, 425–427.—The development of production from the 7000-ft. level in a white limestone of Silurian age in the above area represents the first commercial production found in the State from beds of this age. The well was completed on 13th December, 1940, in a pay-zone between 7010 and 7060 ft., after having been drilled to a total depth of 9187 ft. and plugged back to 7075 ft. 7-inch casing was cemented at 6968 ft., and after being acidized and thoroughly washed, the well flowed 1595 brl. of oil during a period of 12 hr. Gravity of the oil was 32° Bé. The area in which this deep test is located has for ten years been producing oil from sandstone beds of the Whitehorse group, the base of which was found in this well at 2900 ft. Below this depth to 6030 ft. a succession of dolomite and limestone beds of Permian age was penetrated. From 6330 to 6930 ft. siliceous limestone in three different units were found, which correlate with a well on the McElroy field in Western Upton County, 32 miles farther east, at a depth of 10,167–11,153 ft. A white and slightly pinkish, coarsely crystalline limestone was encountered up to 7110 ft., whilst strata of Upper, Middle, and Lower Ordovician were penetrated up to 9187 ft., when, owing to an accident, the well was plugged back to test an upper oil zone. R. J. W.

697.* Correlation of Crude Oils with Special Reference to Crude Oil of Gulf Coast. D. C. Barton. *Bull. Amer. Ass. Petrol. Geol.*, April 1941, **25**, 561–592.—This paper represents a compilation with minor revision of the notes used by the author in his presidential address to the Association at Oklahoma on 22nd March, 1939, and the manuscript of a preliminary draft of a comprehensive paper planned for later publication before death intervened. The late author's assistant, Virgil Moore, and W. P. Haynes rearranged and edited the manuscript and drew the accompanying charts, preserving as far as possible the diction and arrangement of the author.

In an introduction it is stated that discussion of the source and migration of crude oils is invariably beclouded by the lack of any reliable criterion which will serve to distinguish one crude from another, or will permit the identification of a given crude oil throughout all stages of its life-history. Many believe that crude oils migrate upwards across bedding planes from great depths, but this belief rests on indirect evidence. It is seldom possible to identify a given shallow occurrence certainly with the deep-lying counterpart or parent accumulation from which it is believed to be derived. So far we cannot identify a given crude oil with its parent or distinguish crude oils of diverse parenthood, but if it is possible to establish the existence of, and learn to recognize some type of invariant property in crude oils that remains

constant and unchanging throughout the course of their normal evolution, a solution would be expedited.

The author suggests a "gravity–interval pattern" to serve as such an invariant characteristic for the identification of crude oils. This gravity–interval pattern is based on analyses made by the United States Bureau of Mines by the Hempel method, where a distillation cut is taken at 50° C. and at every 25° C. thereafter up to 275° C. under atmospheric pressure, and at 200° C. and every 25° thereafter up to 300° C. at a pressure of 40 mm. of mercury. The A.P.I. gravity of each of these cuts is determined, and this record serves for the portrayal of the gravity–interval pattern of each crude oil. All analyses were classified according to type of base—that is, paraffin or naphthene. For this purpose the A.P.I. gravity of key fraction No. 1—the last fraction obtained when distilling at atmospheric pressure by the Hempel method—is taken as an index. All crude oils in which key fraction No. 1 has an A.P.I. gravity of 40° or lighter are called paraffinic; those between 33° and 40° are classed as intermediate, and those of 33° gravity or heavier are called naphthenic. All analyses of crude oils with the same gravity for key fraction No. 1, measured in degrees A.P.I., are then taken, and the interval in degrees A.P.I. between each cut is noted. These intervals are averaged and plotted in graph form using the gravities of key fractions No. 1 as ordinates and the gravity intervals as abscissæ. The irregular graph for each interval is then represented by a smooth curve, and the mean values of the intervals in A.P.I. degrees listed in tabular form for ready reference for various other crude oils. From the graphs the author can establish from various samples—not identical—a family resemblance. Numerous graphs of oils from different fields well serve to illustrate results of the author's studies employed by him as a standard for identification of crude oils. R. J. W.

698.* North Cowden Field, Ector County, Texas. S. C. Gresey and F. F. Fulk. *Bull. Amer. Ass. Petrl. Geol.*, April 1941, **25**, 593–629.—This field is on the eastern margin of the Central basin platform in North-central Ector County, Texas, 18 miles north and west of Odessa and 30 miles north-west of Midland. In 1924 and 1925 the field first attracted attention, but leasing was carried on slowly and without boom semblance. Ten-year leases were taken, and the nearest producing wells were 125 miles south-east, in the Reagan County at Big Lake field. The discovery well was completed on 11th September, 1930, drilled with a standard rig, with a natural daily flow of 272 brl. On 16th January, 1934, it was shot with 160 quarts of nitroglycerine, and the well received a new proration potential of 777 brl. daily. Numerous and erratic water-bearing strata caused operators to turn to the rotary system of drilling, and during the latter part of 1935 drilling spread in all directions, and a large number of wells brought in. Most operators circulate with live oil to protect porous beds when drilling in with the rotary.

All production of gas and oil in the field is from the Grayburg formation of the Whitehorse group. There are four pay-sands in the first 400 ft. of the Grayburg. The first pay is 50–70 ft. thick; the second about 55 ft.; the third from 10 to 40 ft., as also the fourth. Wells showing considerable anhydride in the pay section make excellent producers. Depth is about 3615–3875 ft. but thickness of Grayburg formation has as yet to be determined. Original reservoir pressure is thought to have been 1750 lb. per sq. in. Up to July 1938 212 wells had been drilled, mostly by rotary, and a deviation of no more than 5° max. is allowed. Drilling time rotary 42 days. Wells are spaced one well per 40 acre unit and 440 ft. from lease lines. 66% of the wells are connected to a natural-gasoline plant of the absorption type with a capacity of 50 million cu. ft. per day against a 30–40 lb. back pressure. R. J. W.

699.* Page Field, Schleicher County, Texas. R. Simpson. *Bull. Amer. Ass. Petrol. Geol.*, April 1941, **25**, 630–636.—This field is in Schleicher County, Texas, 9 miles south-east of Eldorado and 45 miles due south of San Angelo. It is on the western edge of the eastern platform and near the eastern edge of the Black shale basin in the physiographic province known as the Edwards plateau. It is about 70 miles west of the nearest outcrop of igneous rock of the Llano uplift. The discovery well was commenced in 1929, but at 5055 ft. was shut down. In May 1934 the well was deepened, and at 5402 ft. a sweet gas, with a distillate content of 0·7 gal. per 1000

cu. ft., was struck in the following month. The well was carried to 6257 ft. and then plugged back to 5550 ft. and shot with 200 quarts of nitroglycerine at 5400–5445 ft. and, following acidization with 3000 and 8000 gal. of hydrochloric acid, was completed in 1936 as a gas-distillate well with an open flow of 16 million cu. ft. Of the seven wells drilled, four are gas, one oil, and two dry. The four gas-wells have a potential gas production of 170 million cu. ft. One oil-well has a potential of 259·2 brl. of 37° gravity crude. It is now producing 37 brl. daily, with 15 brl. of salt water. A 45-mile 8-in. gas line (welded) from field to San Angelo has been completed for an electric generating and water-pumping plant there. Gas occurs in porous limestone in the Straun series. It is the author's belief that the Page field is not primarily a fold, but rather a reef or depositional "high," possibly over an old positive area with some later folding. R. J. W.

700.* **Summary of Faunal Studies of Navarro Group of Texas.** L. W. Stephenson. *Bull. Amer. Ass. Petrol. Geol.*, April 1941, **25**, 637–643.—The Navarro group in East-central Texas is the uppermost major geologic unit of the Upper Cretaceous series of Texas. Its area of outcrop forms a relatively narrow, sinuous band extending from Red River in Bowie County in the north-east to the Rio Grande in Maverick County in the south-west. The group has been divided into four formational units in ascending order, Neylandville marl, Nacatoch sand, Corsicana marl, and Hemp clay, all of which are of marine origin. The sediments composing them are medium- to fine-grained, and were deposited in waters covering a continental shelf, the limiting depths of which have not been precisely determined, but the character of the fossil faunas suggests that the waters were not deeper than those of the Continental Shelf off the present Atlantic Coast. Recent palæontologic studies have resulted in 411 named species and varieties of the larger invertebrate fossils being recognized. A further 100 poorly and incompletely preserved forms are assigned to genera, but too imperfect for specific identification. Fully 90% of the Navarro fauna as at present known is restricted to the Navarro group and its equivalents. Only one specimen is known to range upward into sediments of Tertiary age. The group is correlated with the Maestrichtian of Europe. R. J. W.

701.* **Analysis of Midway Fauna of Western Gulf Province.** J. Gardner. *Bull. Amer. Ass. Petrol. Geol.*, April 1941, **25**, 644–649.—In the Midway fauna of the Western Gulf province about forty-seven superspecific groups of pelecypods and about sixty-five of gastropods, two of scaphopods, one of cephalopods, and one of Vermes have been recognized. No single species in the Gulf province is certainly known to bridge the rift between the Cretaceous and the Tertiary. The value of the superspecific groups in determining the relationship of the Palæocene fauna to those which precede and follow varies widely. They may be segregated into seven more or less clearly defined assemblages, as follows :—

(1) Genera recorded in the Midway that have persisted from Cretaceous to Recent times;
(2) Those restricted to Cretaceous and Palæocene;
(3) Those restricted to Cretaceous and early Tertiary;
(4) Those restricted, at least in the Gulf Province, to Palæocene and early Eocene;
(5) Those restricted to the Palæocene and Eocene;
(6) Those restricted to the Palæocene, Eocene, and Oligocene;
(7) Those initiated in the Palæocene and continuing to the Recent.

R. J. W.

702.* **Simpson Group of Arbuckle and Wichita Mountains of Oklahoma.** Charles E. Decker. *Bull. Amer. Ass. Petrol. Geol.*, April 1941, **25**, 650–667.—The deep interest in the Simpson group manifested for many years has been steadily increasing. This is due to the various oil and gas formations contained over wide areas, to its asphalt deposits, its excellent glass sand, and to its numerous fossils, making possible correlations both local and widespread.

Because of recent road-cuts it is possible to present several detailed sections;

whilst restudying old sections new information is presented indicating changes in formation contacts, relative thicknesses of formations and extension eastward of the Tulip Creek formation. Additional evidence for earlier omission of Falls as a formation name for the Simpson group is found to be more fully justified, the group consisting of a remarkable series of alternating limestones, sandstones, and shales. The paper includes a graphic section showing Simpson group formations, and several revised detailed sections of the same are given. R. J. W.

703.* Devonian Subsurface Strata in Western Kentucky. L. B. Freeman. *Bull. Amer. Ass. Petrol. Geol.*, April 1941, **25**, 668–712.—The purpose of this investigation is to correlate the subsurface Devonian strata in the Western Kentucky basin with the equivalent beds in the generally distant outcrops. Samples from about forty wells were studied, zoned on the basis of general lithology and insoluble residues, and a tentative correlation of these zones with the outcrop material was suggested. Formations recognized at the surface in Southern Illinois can be traced into the subsurface in Western Kentucky. A map showing area included in this study and its relation to areas of Devonian outcrop is given and a Palæostratigraphic map of the Devonian of Western Kentucky shows probable Pre-Chattanooga distribution of Devonian and subjacent Silurian formations, with sections across same, together with a composite correlation diagram to illustrate the relationship. The paper includes detailed sections of wells examined, also a bibliography. R. J. W.

704.* Study of Sedimentation and Stratigraphy of Lower Mississipian in Western Michigan. L. Hale. *Bull. Amer. Ass. Petrol. Geol.*, April 1941, **25**, 713–723.—Formations representing the lower Mississippian in Michigan have always been considered as unimportant shale sections and have received very little study. Recent drilling developments in Allegan, Kent, and Ottawa Counties have provided good samples, proving that this western area differs markedly in its sedimentary history and presents several interesting stratigraphic problems.

The formations discussed comprise the Coldwater, Ellsworth shales and the upper part of the Antrim formations

The basal member of the Coldwater is red fossiliferous limestone with some red shale; the "Coldwater lime" in many places is light grey dolomite rather than limestone, and has embedded crystals of secondary dolomite and "pepperings" of glauconite. The Ellsworth is present only in the western part of the State, and is grey and greyish-green shale with grey dolomite zones.

The green shales of the Ellsworth grade into, and alternate with, the black shales of the Antrim, making it difficult to determine the top. The oldest formation discussed is the Antrim shale, which caps the producing Traverse limestone, and is considered to be the source bed of the Transvaal. A further detailed account of the Antrim–Ellsworth–Coldwater shale formation by Eleanor Tarbell is discussed on pages 724–733. R. J. W.

705.* Olla Field, La Salle Parish, Louisiana. S. A. Packard and H. R. Kamb. *Bull. Amer. Ass. Petrol. Geol.*, April 1941, **25**, 747–750.—The Olla field is 4 miles east of the Urania field, and 3 miles south-east of the town of Olla, being on the north-east edge of what is called the Central Louisiana district. This new field is the first large producer of oil from sands below the top of the Eocene Wilcox group. Previous important Wilcox fields such as Urania and Eola found production only in the top sand member. The Olla zone is about 470 ft. below the top of the Wilcox, and averages 300 ft. in thickness. Five producing oil and gas sands are known at present within the zone, which is characterized by the presence of glauconitic and calcareous sands and marls suggesting it is part, at least, of shallow marine origin. The field lies on a narrow, elongate north-south anticlinal ridge of small closure along the east side of the so-called Urania uplift.

To 25th November, 1940, seventy-four oil-wells and one gas-well have been completed, forty-four produce from the "upper or lower Central sands," eleven from the nest sand, known as "Mathews sand," nineteen from the next lower sand, known as "Cruse sand," and one from the lowest, known as "Good Pine sand." The average depth is 2250 ft. and wells take about two weeks to complete. A selected

section 40–150 ft. of the Ulla zone is cored, and then an electric survey made before setting the pipe. The wells come in flowing 50–300 brl. daily through a ¼-in. choke. Gas–oil ratio is 250 to 1. One well to 40 acres is the spacing, and some 5½ miles long north to south and ¾–2 miles wide east to west are the present limits of the field. Crude averages 31·5° gravity for all sands except the "Good Pine," which is 27° (average). R. J. W.

706.* Formation Samples from Gun Perforators. J. T. Richards. *Bull. Amer. Ass. Petrol. Geol.*, April 1941, **25**, 752–759.—During the past few years gun perforators have been used in petroleum development work for two general purposes: first, to explore possible producing formations cased off during drilling of old wells, and second, for perforating casing opposite recently drilled producing formations to produce more efficiently oil or gas from the formations, or to eliminate mechanical difficulties.

The author has summarized the result of an examination made by him of the material from 293 spent shells. The material represented 175 ft. of strata from three wells, and included limestone, shale, sandstone, cement, and mud. He established the fact that rock material in quantities sufficient for microscopic examination does collect in the combustion chamber of spent shells, and that this material represented the formation opposite the shell at the time of firing. In all cases material derived from the mud was much less than in ordinary rotary samples of good quality. The following hypothesis formulated by him as a probable explanation of the accumulation of uncontaminated rock samples in the shells:

(1) On penetrating the formation, the bullet displaces by compression, consolidation, and brecciation, the material occupying the space in its path; the loosened material exists in the form of rock dust and rock fragments.

(2) Due to the velocity of the bullet and the vacuum immediately behind a travelling projectile, some of the loosened rock material is drawn into the space opened by the bullet. Possibly gravity pulls some fragments into the space.

(3) The loosened rock material is suspended briefly in the gases propelling the bullet.

(4) The propelling gases contract immediately after full expansion generating a suction from the formation to the shell.

(5) Since this suction is strong enough to carry bullets from the formation back into the shell, it is also strong enough to carry loosened, shattered rock fragments into the shell.

The author explains his methods of treating the samples which were obtained from one area in the Mid-Continent field, and considers that if similar data from other area were obtained by the same means, the result might add materially to knowledge of underground strata and conditions. R. J. W.

707.* Geology of Western Nebraska Demands Careful Prospecting. W. V. Howard. *Oil Gas J.*, 1.5.41, **39** (51), 11.—The granite ridge running from the Barton Arch of Kansas to the Black Hills of South Dakota is readily delineated, but the location of producing horizons connected with it is more difficult. Tests so far show that practically all the producing horizons of the Cretaceous, Jurassic, Pennsylvanian, and older beds, which might be expected in this area, wedge out on the flanks of the high or are truncated by erosion. Only the basal sand—the Reagan or La Motte sand—can be expected over the arch. Hence the search is not so much a matter of finding highs on the arch, as of locating minor flank structures and stratigraphic traps. The cloak of unconformable Tertiary beds renders surface geological work practically useless here, and the erosion of limestones and their coming into contact in places make the interpretation of geophysical work very difficult. Hence stratigraphical tests and detailed subsurface geology are of the main importance. Accurate correlation is essential.

In Nebraska unconformities occur at the base of the Tertiary and the base of the Jurassic, with the Triassic, Jurassic, and Tertiary pinching out irregularly. The Quaternary consists of sands and clays, whilst the uppermost Tertiary is mainly composed of sands. In parts the Niobrara, Carlile, Greenhorn, and much of the

Graneros of the Cretaceous are missing. Indeed, some wells fail to find Cretaceous. The Sundance and Morrison occur, the latter being shaly but becoming sandier to the east, in which direction it overlaps the red beds of the Triassic. In the Permian and Pennsylvanian the Minnekahta limestone, and the Opeche and Hartville formations, have been observed. These may rest directly on the basal sand overlying the granite. The possibilities of Pennsylvanian production seem good in the south-west part of the arch near the Kansas State line, but on the east flank it may be necessary to go 50 ml. east of the crest. Some wells fail to get Mississippian or older Palæozoic beds, but others have found Arbuckle and possible Simpson. The basal sand—a sand, conglomerate, or granite wash—occurs in most wells, and is productive in the Ray Pool.

A map and cross-section are included. G. D. H.

708.* U.S.S.R.—Greater Use of Natural Gas Reserves Planned. Anon. *Oil Gas J.*, 1.5.41, **39** (51), 21.—The production of gas in the Azerbaidzhan fields has increased sharply, and all the fields are said to have exceeded their quotas under the third Five-Year plan during the second half of 1940. However, much remains to be done, especially with regard to reducing waste. Closed pipe-line systems are to be introduced in the Baku, Grozny, Maikop, Ishimbai, and Buguruslan areas, and the recovery of gasoline from natural gasoline is planned.

In the western Ukraine gas is produced for local industrial needs, but the supply far exceeds the demand. G. D. H.

709.* Creole Report Reviews Operations in Venezuela. Anon. *Oil Wkly*, 28.4.41, **101** (8), 51.—In 1940 Quiriquire produced 21,676,451 brl. of oil, and Oficina and San Joaquin production began to move through the 16-in pipe-line to Guanta. Two wildcats were drilled at Socororo, 22 ml. west of Oficina, one being dry and the other only a minor producer. Early this year a third well was completed as a dry hole. In Central Venezuela a wildcat, Gorrin 1, 160 ml. west of Socororo, was dry. In the Leona area a 1000-brl. well was brought in.

Thirty-six producers were completed at Jusepin and eight in the San Joaquin district (Roble and Santa Ana). Nine wells were completed by Standard at Oficina, one at Cumarebo, and a dry hole at Temblador. G. D. H.

Drilling.

710.* Unnecessary Drilling. Anon. *Oil Wkly*, 19.5.41, **101** (11), 11.—Among the more serious evils which directly or indirectly arise from the drilling of unnecessary wells are the following: (1) A large and wholly unnecessary increase in the cost of developing the oil and gas reserves of each pool; (2) an unavoidable steady decrease in the allowable well, not only in a given pool, but also in the state as a whole, resulting in a long-delayed pay-out of wells; (3) an unnecessary and undesirable postponement of full development of pools, resulting in congested drilling in some parts of a pool and insufficient development in other parts of the same pool, causing an inefficient and consequently wasteful use of reservoir energy; (4) a curtailment in discovery and development of new reserves occasioned by the dissipation, in drilling of unnecessary wells, of the funds which would otherwise be available for that purpose.

The drilling of unnecessary wells is occasioned largely through (1) the failure of operators to adopt proper well-spacing programmes, and (2) the allocation of allowable production on the basis of individual well potentials or some combination of factors which give excessive weight to the well without giving proper weight to attributable acreage and reserves.

The writers of this report, the Independent Petroleum Association of America's Committee on Unnecessary Drilling, recommend the following programme: (1) That the orderly development of pools by the adoption of proper spacing programme be encouraged, so that reservoir energy will be efficiently used; waste minimized and maximum ultimate recovery assured to operators and royalty owners alike. (2) That all oil reservoirs be developed with the fewest possible wells, in order that the largest

quantity of proven reserves be made available at the lowest cost. (3) That on the discovery of each new pool, and before a second well is commenced therein, each and every operator who owns acreage within the probable limits of the pool take the initiative in working out a well-spacing programme coupled with a plan for allocating allowable production in the pool which will eliminate, or at least discourage, the drilling of unnecessary wells. (4) That all operators actively undertake a programme of education for the purpose of fully informing all landowners, royalty owners, and the public generally of the substantial benefits to all concerned which will result from orderly development and production methods as against the wasteful practice of drilling unnecessary and unprofitable wells. A. H. N.

711.* **Drilling Costs Cut by Feed-Water Heating System.** G. M. Wilson. *Oil Wkly*, 19.5.41, **101** (11), 13.—The system, due to the raising of the feed-water temperatures before it reaches the boilers, permits the use of one less boiler at each setting; a normal installation of four boilers, for example, is now cut down to three on a certain deep-drilling test in San Joaquin Valley. Naturally, a saving is made in both fuel and installation costs; but an important additional operating advantage is gained by the fact that much less fluctuation of the water in the gauge-glass results when hot instead of cold water is pumped into the boiler.

Exhaust steam from the mud pumps and mud-mixing pumps is collected in a gathering system of light-weight 8-in. welded conductor pipe running along the surface of the ground to a unitized heat exchanger, in which much of the heat is imparted to the circulating boiler feed-water. The heat exchanger is described.

Exhaust steam from the two feed-water pumps is also utilized by allowing it to pass through a coil of pipe laid in the bottom of the skid-mounted water-supply tank spotted near the boiler setting. Water from the water well coming out at approximately 60° F. is raised in this preliminary heating stage to approximately 80–90° F. This warmed supply water is then taken up by the feed-water pump and forced through the large exchanger; while passing through this latter system the water temperature rises to 200–218° F. The final temperatures in all cases vary 10–20° either way, depending on the rate of drilling and the consequent volume of exhaust steam that is made available to the heat exchanger. A back pressure of approximately 15 lb. is built up in the steam-gathering system, due to the restriction formed by the exchanger. A. H. N.

712.* **River-bed Drilling.** J. A. Kornfeld. *Oil Wkly*, 19.5.41, **101** (11), 15. A description of the rig and practices followed in a river-bed drilling programme in a part of Kansas is given. Derrick, rotary table, draw-works, motors, and slush-pump are unitized on one large skid. This is easily skidded into position on the pile structure, making for a minimum of rigging-up time. The front end rests out over the river on the pile structure, whilst the rear end rests on the river-bank. The chief advantages of the rig are the brief time required for rigging up and tearing down, and elimination of expense for derrick erection. The rig can be moved from one completion on to the next location in approximately 48 hrs.

Drive-pipe practice in one well called for 43½ ft. of 13-in. casing cemented with seventy-five sacks. However, all subsequent wells were drilled with from 40 to 70 ft. of 10-in. 40-lb. seamless casing. This pipe is driven by the piling-driving contractor at the same time as the piling is driven. A steel-drive shoe is used on the bottom joint, and a steel-drive head in the top collar. The collars on each joint are welded, and alignment is checked closely during the driving, so as to keep the pipe vertical. The drive-pipe facilitates drilling through the loose river-bed sand; it also prevents washing sand from below the immediate surface of the river-bed. Since the pipe is driven until a solid foundation is reached, there is a variation in length.

Drilling and cementing operations are briefly discussed. A. H. N.

713.* **Cement Spray Bailer Used to Combat Caving Shale.** A. C. MacIntyre. *Oil Gas J.*, 1.5.41, **39** (51), 36.—The device does not completely eliminate the problem, and there are times when there is no other remedy than to cement and drill through the troublesome sections; but it has proved effective in many cases.

The cement spray-bailer, as its name implies, sprays a thin coating of cement on

the face of the shales and forms a crust which aids in preventing caves. The cost of such spraying is much less than that of a full-hole cementing job and drilling through. The shales can be sprayed much faster than the time required for a full-hole job. Use of the device thus reduces drilling time lost in cementing in, and also provides a better hole, often obviating costly fishing jobs.

There are several types of bailers on the market. One consists of two attachments which screw on the top and bottom of several joints of 3-in. tubing. One contractor generally uses three joints, each about 20 ft. long, thus giving him a bailer about 60 ft. long. One type trips, opening the jets, when it strikes the bottom of the hole. Another is operated by a weight dropped down the line. In one type the cement is ejected from two holes, one directly opposite the other. In another type there is a ring of holes around the bottom of the bailer.

The cement is sprayed on the face of the shales as the bailer whirls in the hole, rotated by the spinning of the sand-line, which turns when a weight is suspended from the wire. The rate of the spin lessens as the bailer becomes lighter, due to the cement emptying from the bailer.

Details of cement consistency and operation of bailer are given. A. H. N.

714.* Directional Drilling of Holes through Hard Formations. H. F. Simons. *Oil Gas J.*, 8.5.41, **39** (52), 50.—Probably the most outstanding job in hard-rock country in recent years has been the drilling of wells under Lake Centralia in the Salem, Illinois, field. All wells were directionally drilled from sites along the lake-shore to predetermined points beneath the lake. These wells were completed by cable tools, and were later deepened to lower pay horizons by the same method. The total controlled footage drilled amounted to 35,000 ft., the total horizontal displacement being 5458 ft. The greatest lateral distance to which a well was directed was 432 ft. The average deflection well was 248·12 ft.

The principal reason for the increasing use of directional drilling in hard-rock areas is the improved technique, which has reduced the cost and time required to complete the job. A desired objective may be gained by using as few as four whip-stocks, where formerly a large number might have been employed. This saving is accomplished by studying the formation and taking advantage of the normal dip if it is possible to do so. The study of normal bit action and the tendency of a hole to drift have also been helpful, and a better knowledge of the effect of weight on the bit has been acquired.

Directional holes have been drilled with a deviation from the vertical of as much as 45°, and some engineers believe that it is easier to maintain a high angle than a lesser one. Other engineers prefer to start higher and maintain a lesser angle over a greater distance. The claim for this method is that it requires fewer whipstocks and less time, and the wear on the drill pipe and equipment is reduced. Experience has shown, however, that drift angles at about 8–10° maintain direction very satisfactorily in most conditions.

Certain details of the mechanics and operations of directional drilling are discussed. Side-tracking, straightening, and controlled directional drilling are discussed under three separate sections, giving the usual procedures followed. A. H. N.

715.* Effect of Crooked Wells on Exploitation. H. C. H. Thomas. *J. Inst. Petrol.*, May 1941, **27** (211), 157–164.—Attention is directed to the adverse effects of unintentionally deviated wells on the orderly exploitation of an oil-field. These effects comprise: incorrect spacing at the production level, resulting in inefficient drainage; incorrect interpretation of structure; errors in forecasting; failure to complete the well; failure to produce the completed well to exhaustion. It is shown that a directional survey of every well drilled is not only of considerable value to the exploitation geologist, but is the only way in which progress towards the drilling of straighter holes can be assessed. B. M. H. T.

716.* Slim-hole Drilling on the Gulf Coast. I. W. Alcorn. *Petrol. Tech.*, March 1941, A.I.M.M.E. Tech. Pub. No. 1305, 1–14.—On the Gulf Coast probably the optimum size of slim-hole would have 8¼-in. surface casing with a 7¾-in. hole, and the minimum hole size would be 6¼ in. Not until 1937 was serious consideration given

to the use of slim-holes for drilling to 7000–9000 ft. Points in favour of their adoption were as follows: On the Gulf Coast new discoveries represent odds of about 7 to 1 against the discovery of commercial production, and 10,500 ft. represents the lower limit of economical production, with the odds increased against even finding oil production below that depth. Thus a rig with a drilling limit of 10,500 ft. or less will suffice, and a smaller and compact diesel or gas-engine rig is satisfactory, and reduces the cost of foundations, fuel, and moving in. Reduction of the hole-size reduces the cost of bits, drilling, reaming, casing, and mud. Coring is also reduced according to this policy. Thus the overall cost is only a quarter to a half that for a large hole.

Comparison of data for a series of wells of similar depths and other characteristics, but of different sizes, shows that reduction in size reduces casing and fuel costs, time, bit changes, reaming, footage and mud costs, and increases the footage/hr.

Electrical logging, mud-stream sampling, and side-wall sampling and coring have reduced the amount of ordinary coring necessary. Gun-perforating has changed completion programmes and reduced rig times and overall cost. Improved cementing technique has reduced gas and water encroachment hazards. A 136-ft. derrick with a 26-ft. base and 85-h.p. engine is common, and there has been a trend towards the use of hydraulic couplings. 8¾ in. seems to be the minimum size for digging below the surface with rock-bits.

Numerous tables and curves set out the data relevant to the drilling of holes of different sizes. G. D. H.

717.* Flow of Muds, Sludges, and Suspensions in Circular Pipes. D. H. Caldwell and H. E. Babbitt. *Industr. Engng Chem.*, 1941, **33**, 2, 249.—A theoretical analysis of the flow of sludges in circular pipes is presented. Two types of flow—plastic and turbulent—are shown to occur, the change from one type to the other taking place at the critical velocity. The application of the plastic flow equation to a problem involves a knowledge of the coefficient of rigidity and the tangential unit shearing stress of the sludge. The value of these constants may be determined experimentally in a modified Stormer viscometer. Details of experiments on the flow of sludges of different types in pipes of various diameters at several rates of flow are given, and these data are shown to be in excellent agreement with the theoretical analysis of plastic flow. Theoretical equations supported by experimental evidence are given for the determination of the critical velocity. Under turbulent flow conditions the viscosity of the sludge dispersal medium governs the flow, and the ordinary Reynolds Number–Fanning friction faction relationship may be used. Experimental evidence in support of this is also given. J. W. H.

718. Measuring Particle-Size Distribution and Colloid Content of Oil-Well Drilling Fluids. G. L. Gates. *U.S. Bureau of Mines, Report of Investigations*, No. 3549, February 1941.—This report emphasizes the importance of the colloid content as a constituent of mud-fluid for well-drilling. Without colloids the solids in the fluid would rapidly settle, and consequent deterioration in sealing and wall-building properties would ensue.

During the course of investigations by engineers of the Bureau of Mines concerning characteristic properties of mud fluid, the need arose for a rapid, reliable method of measuring particle-size distribution and determining colloid content. Studies were accordingly made of published methods, and a standard procedure based on the hydrometer method of analysis was evolved. The procedure differs from previous methods mainly in the manner in which the sample is prepared for analysis, in the absence of a deflocculating agent, the application of a correction factor for dissolved materials which occur in most mud fluids, and in measuring the viscosity of the suspension.

Although results obtained by the hydrometer method are not absolute, they agree closely with those obtained by the pipette method, which is a direct method of particle-size analysis. Moreover, size-distribution curves plotted from results of nearly all the samples tested by the Bureau indicate that the cumulative weight percentages determined by the hydrometer method of analysis form a continuous relationship with the cumulative weight percentage determined by sieve analysis.

Advantages of the hydrometer method equally include simplicity of equipment and test procedure; easy and quick calculation of results of analysis by means of a slide rule and tables; and provision of a means of prediction of possible behaviour of the fluids after accumulation of sufficient data. H. B. M.

719. Patents on Drilling. R. Neuhaus. U.S.P. 2,239,826, 29.4.41. Appl. 15.7.40. Tool-joint with a coupling member with larger diameter than pin members adapted to receive wear incident to operation.

F. Stone and A. L. Stone. U.S.P. 2,239,942, 29.4.41. Appl. 17.5.39. Well pipe-joint.

J. F. Chappell. U.S.P. 2,239,996, 29.4.41. Appl. 25.5.36. Drilling apparatus comprising a bit on a drill-pipe with another pilot bit being located on another pipe which is inserted inside the first pipe.

L. H. Giles. U.S.P. 2,240,095, 29.4.41. Appl. 25.8.38. Rock drill-bitcone-catcher which is to be used as a fishing-tool.

R. Ring. U.S.P. 2,240,417, 29.4.41. Appl. 7.10.38. Apparatus for surveying wells by means of a pondulum having a point contact with a record and a low voltage current inducing electrolytic changes on the record chart, thus marking it.

A. R. Reed. U.S.P. 2,240, 519, 6.5.41. Appl. 31.8.38. Drill string-shock absorber adapted for flow of slushing fluid through it.

F. J. Young. U.S.P. 2,240,737, 6.5.41. Appl. 14.4.37. Draw-works having an enclosure surrounding the transmission element.

J. A. Dunn. U.S.P. 2,240,738, 6.5.41. Appl. 14.7.37. Rotary drilling rig with the drill-string extending into the kelly, which is aligned by a taper with the swivel.

J. D. Spalding. U.S.P. 2,240,741, 6.5.41. Appl. 5.2.40. Draw-works with two shafts, one of which is adapted to convey a fluid.

J. C. Mason. U.S.P. 2,240,794, 6.5.41. Appl. 11.3.40. Drilling lift consisting of a pair of hydraulic cylinders attached to the derrick legs and containing pistons connected to lift-cables.

C. J. Moon. U.S.P. 2,240,852, 6.5.41. Appl. 20.1.40. Derrick structure which is capable of being raised from horizontal to vertical position.

J. Neufeld. U.S.P. 2,241,154, 6.5.41. Appl. 1.10.38. Well-surveying method and apparatus to determine the nature of formations penetrated by the drill-hole by measuring the fluorescence of substances present in the formation and the depth simultaneously.

A. D. Garrison. U.S.P. 2,241,255, 6.5.41. Appl. 17.8.39. Oil-base drilling fluid.

W. W. Robinson and R. R. Crippen. U.S.P. 2,241,273, 6.5.41. Appl. 1.7.39. Method and apparatus for treatment of drilling mud.

G. A. Severson. U.S.P. 2,241,274, 6.5.41. Appl. 27.9.38. Safety device adapted to disconnect the engine from the draw-work and to apply the brakes in cases of emergency.

E. Shinn and E. Shinn, Jr. U.S.P. 2,241,275, 6.5.41. Portable hoisting apparatus. A. H. N.

Production.

720.* Oil Recovery by Air and Gas Drive in Pennsylvania. R. B. Bossler and P. A. Dickey. *Oil Gas J.*, 1.5.41, **39** (51), 32. *Paper Presented Before American Petroleum Institute.*—There appears to be a definite relation between ultimate oil recovery and well spacing. If the well spacing is decreased to small values and the distances between wells becomes absurdly short, the oil recovery will increase more and more

slowly, tending to approach as a limit the total amount of recoverable oil in the sand. On the other extreme, where the spacing becomes so great that the input wells do not affect the producing wells, the recovery will approach zero.

A curve of this shape may be expressed by the general formula : $y = ae^{-bxP}$.

A reasonable value for a must be assigned by deducting the unrecoverable oil from the total oil in the sand. In the Venango district the constant a becomes 140. Values may be assigned as follows : $y = R$ = cumulative ultimate recovery, brl./acre-ft. $x = F$ = square root of product, acres/oil wells times acres/air well. $a = 140$. $e = 2{\cdot}7183$ (base of Naperian logarithms). b and P = constants depending on local conditions.

It is necessary to relate the spacing to the fraction of total recoverable oil that will be recovered, instead of to the actual oil recovered. The equation becomes : $R = e^{-0{\cdot}29F^{1{\cdot}49}}$, where R equals fraction of total recoverable oil recovered at geometric mean spacing F.

A formula is developed for optimum well spacing for any set of conditions. This formula leaves out consideration of the beneficial effect of close spacing, as the leases studied did not allow derivation of a quantitative relation between spacing and time of recovery. The authors' data showed clearly that close spacing increases the rate of recovery and accelerates the rate of production decline, so that not only does close spacing result in greater ultimate recoveries, but the oil is recovered faster.

If a certain development will produce a certain quantity of oil in 10 years from a given area, with oil production declining in a logarithmic manner, the present worth of the future income will be about 85% of to-day's value of the total quantity of oil. If 20 years is required to recover the same amount of oil from the same property, the present worth of the future income will be about 65% of to-day's value of the oil. If other conditions are the same, it is about 25% more profitable to extract the oil from a property in 10 years rather than 20 years.

Closer spacing and more rapid recovery will result in decreased lifting costs and more efficient extraction of the oil in the sand. Use of high pressures at the start will result in the removal of some of the oil from the less permeable sections of the sand.

The paper also includes a discussion of the various gas- and air-drives in Pennsylvania outside the Venango district. A. H. N.

721.* Automatic Controls Close Wells when Tank Battery is Filled. D. H. Stormont. *Oil Gas J.*, 1.5.41, **39** (51), 35.—A two-well tank battery has been equipped with valves and controls for automatically shutting in the wells when the tank battery is filled. This experimental equipment has been satisfactorily operating for 10 months. The equipment also provides means whereby individual wells may be stopcocked from the central tank-battery manifold. Judging from operations of the experimental battery, installation of this equipment at each tank battery on the Cowden lease will, it is estimated, result in switchers' labour being reduced by about 40%, and, by reducing the number of trips to open and close the wells, car mileage of the pumpers should be reduced by almost half. Tests indicate also that, through use of stopcocking, the gas–oil ratios of the wells can be reduced by almost 100 cu. ft./brl.

The equipment consists of (1) an 8-in. liquid-level controller with pilot on the tank battery; (2) a single-seated diaphragm-operated pressure regulator and oil-valve installed between the manifold and separator; (3) a 1500-lb. working-pressure regulator installed behind a positive choke, which follows an adjustable choke, at each of the wells; (4) standard separator float control; (5) a spring-loaded relief valve on a by-pass around the pressure-regulator at the tank-battery manifold. The working of the equipment is described and illustrated.

The equipment is of particular value where wide well-spacing is practised or where a lease is remotely located. A. H. N.

722.* Cathodic Protection to Prevent Corrosion of Gas-Well Casing. W. E. Huddleston. *Oil Gas J.*, 8.5.41, **39** (52), 59. *Paper Presented Before American Gas Association.*—The theory of corrosion and of cathodic protection is explained. After discussing the practicability of protecting gas-well casing cathodically, the following conclusions are reached :—

With certain limitations, cathodic protection may provide an economical means of combating corrosion on gas-well casing.

Many problems, however, arise out of the design of a cathodic protective system for this application, the most serious of which is a source of power for supplying the protective energy. Other problems arise in the manner of determining the necessary load requirements for a given string of casing, the fabrication of a suitable low-resistance anode in locations having adverse soil conditions, and the question of being able to apply cathodic protection to a corroding well in sufficient time to save the casing from penetration.

In view of the results obtained by insulating, it is quite apparent that casing corrosion can be mitigated sufficiently by this method alone to prolong the useful life of the casing for several years, provided the well is insulated before the casing wall has reached penetration or near penetration. Obviously the most satisfactory practice would be to insulate new wells as they are completed. Experience gained from insulating gas-wells during the past 4 years indicates that, in general, the useful life of well-casing can be at least doubled (even when it is subject to severe attack), provided the well is insulated at the time it is connected to the gathering system, or within a few weeks after.

Multiple wells connected to the same gathering system demand special consideration, as the corrosion rate on the uninsulated wells will usually be accelerated by insulating all or part of the other wells.

The economic benefits gained by insulating a number of wells can only be determined by actual tests in the field, for some wells corrode at a much higher rate than others. A. H. N.

723.* Intermittent Injection of Air Aided by Electric Clocks. A. C. MacIntyre. *Oil Gas J.*, 8.5.41, **39** (52), 70.—In order to determine the optimum intermitting schedule in a particular field, the operator used a number of synchronous clocks which operate on a 110-v. 60-cycle current, throwing a switch either at 30-min. or 1-hr. intervals. The clocks were arranged to open a solenoid valve, and could be so adjusted that the valve closed at the will of the operator.

After various "on" periods were tried, a schedule of 8 min. "on" and 22 min. "off" was adopted. The intake pressure used allowed 45,000 cu. ft. of air to be admitted to the sand each 24 hr. In 62 weeks of operation the production from wells surrounding this arrangement amounted to 6730 brl. of crude. This compared with 1560 brl. of crude for 62 weeks under continuous repressuring, or a gain in production by the intermittent repressuring of about 432%.

It is noted that with regular injection a pressure of only 20 lb. was required, whilst a pressure of 125 lb. was used with the intermittent injection.

It was not necessary to attach the electric clock to all the wells to obtain results. All were affected by the rise and fall in pressure as the valve was opened and closed by the electric clock.

The theory behind the experiment is that the Venango third sand has a very extreme range of permeability. Probably the oil strata being worked at 20 lb. was not more than 4 or 5 ft. thick, out of a total of 32 ft. of exposed section. The injection of air in intermittent slugs caused a Jamin action in the more permeable strata of the sand, and thus permitted injected air to be introduced into the less permeable area. These less-permeable strata have a higher oil content, and thus the production was increased. A. H. N.

724.* Electric Power Pumping-Plant Designed for Present and Future. G. B. Nicholson, *Oil Wkly*, 5.5.41, **101** (9), 14–16.—A wide diversity of well characteristics is a peculiarity of many wells producing in the East Texas field. All producing from the Woodbine sand and apparently completed similarly, many wells bear only the slightest resemblance to their neighbours. Productivity varies sharply; in the pumping wells, fluid-levels and water-content are widely divergent. With sixty wells on the leases an inefficient pumping assembly would result in considerable waste expenditure in equipment and man-power.

An electric-generating power-plant with individual electrically controlled units at the wells was selected as the power. This type installation offers considerable

flexibility in operation. Constructed with the idea that future power requirements may be greater than those at present, the assembly will permit expansion at low cost when occasion arises. A detailed description is given of the major items of the plant. A. H. N.

725.* **Dehydration Units for Individual Gas Wells.** R. B. Anderson. *Oil Wkly*, 5.5.41, **101** (9), 17–19. *Paper Presented Before American Petroleum Institute.*—A dehydration plant located at isolated wells must be designed to meet the following conditions: (1) It must be completely automatic and require no more than casual inspection by the regular field force. (2) It must be simple in operation, so that unskilled common labour can understand its operation and make adjustments when necessary. (3) It must obtain what power is required from gas pressure; no other is available. (4) Water for cooling or steam is not available. (5) The solution must not be corrosive, and must be such that if over-concentration does occur, no harm will result. (6) The method must appreciably depress the dewpoint, so that small quantities of untreated gas can be mixed without raising the dewpoint of the mixed gas above the minimum ground temperature. (7) It must be inexpensive.

The paper describes a well-head dehydrator that was finally adopted to meet the above conditions. There is really nothing new in the method employed. It is the conventional diethylene-glycol dehydration plant. It is unique only in various features of its design to meet the limiting factors of a well-head dehydration unit.

Gas saturated with water vapour enters the contactor through the inlet pipe above the base of the contactor, and passes up through three bubble-trays, where it contacts the diethylene glycol solution that is flowing down through the contactor. This contact is sufficient to absorb all the water the diethylene glycol is capable of absorbing from the gas.

There has been developed another type of unit that is adaptable to dehydrating gas at the well that meets all the limiting factors for such plants.

The unique feature of this design is that no pump is required and the still is operated at line pressure, the water removed and condensed under pressure and discharged through a trap from the unit.

Gas enters the contactor near the base, where it contacts the diethylene glycol solution. The solution passes up through the trays of the tower to the top tray, where it drains through an overflow line to an "adjustable flow control." The adjustable flow-control is a chamber in which is located an adjustable weir which controls the volume to be discharged to the still. The solution passes to heating coils in a hot-oil bath and then to the still under full pressure. A. H. N.

726.* **Gas-Well Spacing.** W. P. Smith. *Oil Wkly*, 5.5.41, **101** (9), 20–21. *Paper Presented Before American Petroleum Institute.*—The problem is studied from an economic viewpoint focussed upon experience gained from Elk-Poca field. Although there have been some few notable exceptions, in general up to the present the development of the Elk-Poca field, near Charleston, West Virginia, has been on a rational basis, and is on the whole economically sound. However, caution will have to be used henceforth in order to avoid some of the costly uneconomic results of poorly planned well spacing.

There is probably no general formula which can be made to fit all cases in determining the optimum in well spacing. Each company or operator should, for his own, as well as for the common welfare, seek to follow a programme of well spacing which will, so far as is predictable, serve his needs, and at the same time conflict as little as possible with the development programme of his neighbour. In other words, unnecessary overcrowding of offset wells should be avoided. It is not recommended that any operator or group set up a fixed and inflexible well-spacing programme, because each one has problems as to acreage, location of acreage, market demand, and reserves which are peculiar to his own operation. It is recommended that careful study be given all available field and production data, to the end that each operator may estimate for himself the economic factors relating to his own part in the development of new sources of production.

One of the most obvious needs of the operators in the development of new deep producing structures is for unitization of small contiguous acreage groups, wherever

possible, into sufficiently large blocks to avoid unnecessary and uneconomic over-drilling due to requirements for offset wells.

The belief is expressed that the industry will find it ultimately of great general benefit to undertake a programme of education for the royalty owners and of self-education for the industry, to conserve and prolong the useful life of producing fields through adequate and economically sound spacing of wells, bearing in mind that what may be sound economics for one company or one operator may not necessarily be so for another. A. H. N.

727.* Minor Sands Water-flooded with Success. F. R. Cozzens. *Oil Wkly*, 5.5.41, **101** (9), 28.—In redrilling many of the minor fields which had been abandoned for 20–40 years, operators were surprised to find in the sand of a newly drilled well a head of fresh, lively oil, somewhat resembling the original flush production. Gas, too, was commonly in evidence, and often in amounts sufficient to operate the equipment. The same operators were far more surprised when, after a few months' to a year's pumping, the oil and gas suddenly gave way to floods of fresh water, and the well was ruined. The cause was easily determined. Many of the original wells, being carelessly plugged, had filled with water, and its weight and volume had been sufficient, over the course of years, to penetrate the sand for a considerable distance, pushing the oil and gas before it. This gradually resulted in an extremely rich pay in the sand-body between the old holes, and a newly drilled well invariably tapped it.

Old wells had been drilled on an average of 200 ft. apart, and the crooks and width of the pay formation had been fairly well determined. New wells could be drilled at costs ranging from $300 to $1000, and, while short-lived, each could be expected to yield 1000 or more barrels of oil before the water came through. The recovery plan which was then mapped out, and is now being followed, is to drill or stagger new wells as nearly as possible in the centre of the sand-streak, and midway between two of the old locations. The drill invariably brings oil, and the narrowness of the streak is an advantage, since the incoming water volume is confined to restricted areas. The new wells are given a light charge of nitroglycerine and pumped vigorously for the duration of their life, which may vary anywhere from a few months to five years. The speed at which the water travels through a formation depends on the depth and texture of the sand, and the number of old wells which are taking water. Some wells, of course, have been plugged sufficiently to prohibit the drainage of water into the sand. A. H. N.

728.* Unsteady Flow of Heat through Porous Media. H. B. Harbut, D. C. Cain, and R. L. Huntington. *Industr. Engng Chem.*, 1941, **33**, 2, 257.—The investigation was undertaken with the object of obtaining data applicable to the recovery of oil from spent oil-sands. The data given are, however, applicable to any large-scale porous media heating problems. The relative rates of heat-flow through porous media of different pore-size and of different interstitial fluid fillings are presented. The results indicate that in the case of the smaller grains conduction is the factor governing heat transfer, whereas in the case of large spheres convection in the liquid filling the interstices governs the heat-transfer rate. J. W. H.

729*. Development and Application of Subsurface-pressure Data in Kettleman Hills. E. W. McAllister. *Petrol. Tech.*, March 1941, A.I.M.M.E. Tech. Pub. No. 1303, 1–16.—The first subsurface pressure measurements at Kettleman Hills were made in 1932, and in 1933 they became part of the routine. The productivity index is the number of barrels of oil and/or water which will enter the well per day per lb./in.^{2} pressure drop at the well-face. This index was found generally to decrease with time and to vary with the rate of flow. Static pressure measurements were also made with the wells shut in, and the flow-pressure gradient was determined in the flow-string. From these data the potential of a well can be computed, for it is equal, theoretically, to the product of the productivity index and the maximum mean pressure draw-down that can be made opposite the producing interval of the well. An example is given of such a computation. The potential decline and "absolute" potential decline can also be plotted, the latter being the potential if all pressure could be removed from the surface of the producing sand.

In the development of Kettleman Hills it has been the policy of the Kettleman North Dome Association to complete only enough wells to maintain a 60 lb./in.² (surface producing pressure) field potential, and to determine the number of drilling strings necessary, a potential-decline curve for the field is plotted, based on individual well potentials derived from production and subsurface data. Superimposed on this curve are the expected increases in potential from future completions for different numbers of drilling strings. Thus the drilling programme can be drawn up.

Subsurface pressure data are valuable in the solution of gas-lift problems such as tubing depths, surface pressures, etc. In wells of small production rates, intermittent gas-lift is more efficient than straight gas-lift, and generally increases production.

The distribution of production and acreage amongst the various leaseholders is discussed in detail. Concentration of production in competitive areas has given an unbalanced condition of reservoir pressure, and excessive gas production has reduced the ultimate oil recovery. G. D. H.

730.* Some Factors in the Economics of Recycling. E. Kaye, *Petrol. Tech.*, March 1941, A.I.M.M.E. Tech. Pub. No. 1304, 1–10.—To determine the amount of distillate in place involves a knowledge of acreage, sand thickness, reservoir pressure and temperature, porosity and connate water content of the sand, and an estimate of the distillate content of the gas. This last is the most difficult measurement. An ultimate distillate recovery of 60–70% seems the best that can be expected. The recovery depends also on the maintenance of pressure above the dew-point, otherwise there is loss by condensation in the sand.

Recovery plant size is determined by the extent of the reserves, gas market, cost of production and condensate market. Plant cost is discussed and ranges \$8–\$13 per 1000 cu. ft. of gas capacity/day. Operating costs per unit of capacity vary with reservoir pressure, condensate content of gas, extraction efficiency, character of condensate, and gas capacity of the wells. Costs range \$0·0201–\$0·0246/gal., with condensate worth \$0·025/gal., depreciation and raw material being allowed for.

Typical condensates are composed essentially of hydrocarbons boiling within the motor-fuel ranges (75%), with various percentages of natural gasoline (10%) and kerosine distillate (15%). Condensates are neither particularly volatile nor high in anti-knock. They more nearly approximate to the products of simple distillation of crude oil. Condensate is not sought by refiners, even though it appears to be more valuable than crude oil, and consequently plants have been designed to distil the condensate into its components, producing reasonably satisfactory fuels, including leaded grades, entirely without reforming.

Soon there will be a production of 50,000 brl./day of condensate from thirty plants, and this, considered as crude oil, should not present a producing or marketing problem, although if converted into end-products a problem does arise.

The appendix deals with gas-sampling methods and condensate recovery costs, and lists the recycling projects in operation, under construction, and planned.

G. D. H.

731.* Proration—Part 1. O. W. Willcox. *World Petrol.*, May 1941, **12** (5), 36–41.—The author suggests that proration in the oil industry suffers shortcomings which could be eliminated if a system similar to that of the sugar industry could be adopted. Judged by standards set in the world sugar industry, the system of proration now found in the American petroleum industry has the following principal shortcomings: (1) It is not nation-wide; the prorating laws passed by individual States have no effect beyond their own boundaries, and the oil producers of non-prorating States remain free to throw upon the market whatever amount of oil they please. Moreover, the prorating States are not always of one mind as to the proper basis of proration, especially as regards the allowables that are prescribed from time to time. (2) The amount of oil coming on for sale is out of control not only as regards the unlimited production of the non-prorating States, but also as regards new production anywhere. Whenever a new oil-pool is discovered or a new well is opened in an old field, this new production may and does claim a place in the existing scheme of proration; to give the new oil its place, previous allowables must be reduced. This

continual whittling away of allowables continually reduces current earnings and prolongs the time required for the operator to pay-out his investment, and not infrequently removes the possibility of a reasonable pay-out. (3) Due to the pressure of non-prorated oil and to new flush production, the visible stock of petroleum products is subject to comparatively large variation, with a strong tendency to overhang the market. Prices vary with each change in the statistical position, alternately squeezing the oil producers and the consumers. This uncertainty and instability of oil prices has a disturbing effect on the economics of investment, production processing, and consumption.

An outline is given of the concepts of proration to be adopted, as these concepts found world-wide success in the sugar industry. Of these concepts, two—the sixth and seventh—are new and controversial to oil-men. They are: (1) (concept No. 6) the business of the industry belongs to the whole industry as it stood at the time it was constituted as a unit. Once the industry has been recognized as a contractual entity, the membership list is closed, and is not reopened except when additional facilities for production are required to meet an increased demand, or for some exceptional reason. (2) (concept No. 7) The prices which the industry shall charge the public for its products will be named in the contract or agreement with the public authorities, and will not be subject to change except at stated periods and after prior consultation between representatives of the industry and the public; and these prices will be uniform throughout the country.

These are discussed in detail. A. H. N.

732. Patents on Production. W. H. Hunter. U.S.P. 2,240,780, 6.5.41. Appl. 5.1.39. Flat-groove valve-body and packing means therefor, forming a pump plunger.

W. Ferris. U.S.P. 2,240,901, 6.5.41. Appl. 20.2.36. Hydraulic transmission adapted to be lowered into an oil-well consisting of hydraulic motor, pump, and valve mechanisms.

M. De Groote and B. Keiser. U.S.P. 2,241,011, 6.5.41. Appl. 23.10.39. Process for resolving petroleum emulsions of the water-in-oil type.

J. R. Henry and R. P. Downing. U.S.P. 2,241,090, 6.5.41. Appl. 3.1.39. Pumping unit consisting of supports carrying a shaft with an eccentric which has a roller on it connected to a crosshead, which is in turn connected to the polished rod.

T. W. Murray. U.S.P. 2,241,153, 6.5.41. Appl. 9.4.40. Well-pump operating equipment for operating the sucker-rods consisting of a shaft and at least three wheels, two to oscillate the shaft and the third to be connected to the rods.

A. D. Garrison. U.S.P. 2,241,253, 6.5.41. Appl. 10.6.38. Method of treating wells to convert a water wet producing sand into one which is preferentially wettable by oil.

A. D. Garrison. U.S.P. 2,241,254, 6.5.41. Appl. 6.7.38. Method of treating oil wells.

J. R. Yancey. U.S.P. 2,241,288, 6.5.41. Appl. 26.1.40. Apparatus for completing wells.

R. Smith. U.S.P. 2,241,333, 6.5.41. Appl. 24.7.34. Well-head. A. H. N.

Crude Petroleum.

733. Analyses of Crude Oil from Phillips Co., Kansas. Anon. *Petrol. Engr*, Jan. 1941, **12** (4), 64.—Phillips County crude oil from the Logan Pool, Kansas, is an intermediate base crude with S.G. 0·867, sulphur 0·57%, carbon residue 5·3% and viscosity S.U. at 77° F. and 100° F. of 100 sec. and 72 sec., respectively. A Bureau of Mines analysis gives the following yields: Light gasoline 7·3%, total gasoline and naphtha 24·0%, kerosine distillate 8·8%, gas oil 14·7%, non-viscous lub. dist. 10·2%, medium lub. dist. 7·5%, and residuum 33·8%. C. L. G.

Cracking.

734. Hydroforming is New Dehydrogenation Process. D. J. Smith and L. W. Moore. *Petrol. Engr*, April 1941, **12** (7), 23.—The first commercial hydroforming plant has been put into operation at a Texas City Refinery, and is capable of reforming 7500 brl./day of heavy mixed cracked and straight-run naphtha of 40–45 O.N. giving an 80% yield of gasoline of about 80 O.N. The process consists of treatment at a high temperature with the hydroforming catalyst resulting in ring closure and dehydrogenation, the hydrogen produced being partly recirculated with the fresh feed in order to control the rate and extent of dehydrogenation. The gasoline produced contains a high percentage of aromatic hydrocarbons and only a small quantity of aliphatic unsaturates, and is sufficiently stable for direct blending into gasoline. Fresh feed and hydrogen-rich recycle gas are heated by heat exchange and passed to a two-coil furnace, mixed and passed to the high-pressure catalytic reactors, conditions being designed to avoid thermal cracking before contact with the catalyst. The hot reaction products are cooled and passed to a gas separator, the liquid from which is stabilized and re-run to remove heavy polymers. Coke deposition on the catalyst reduces its activity, but this is restored by burning off the reactors with flue gas and air under carefully controlled conditions. Typical analyses of (*a*) charge and (*b*) hydroformed product are as follows: Gravity A.P.I. (*a*) 51·4, (*b*) 51·3; O.N. (*a*) 47·2, (*b*) 77·0; Reid V.P. (*a*) 0·4 lb., (*b*) 8·2 lb.; I.B.Pt. (*a*) 222° F., (*b*) 79° F.; 50% dist. to (*a*) 292° F., (*b*) 270° F.; and F.B.Pt. (*a*) 436° F., (*b*) 368° F. The hydroformed product contains 40–50% aromatics, of which 15–20% are toluene, the rest being predominantly xylenes and higher. The flexibility of the process allows either straight-run or cracked naphthas to be reformed to produce motor spirit or aviation gasoline which require no refining. By modifying conditions a product with 80% of aromatics can be produced, thus providing an important source of toluene. The products from the plant in question alone contains a quantity of toluene equal to 25% of the U.S. production for 1939 (20 million gallons). C. L. G.

735. Patents on Cracking. C. Arnold. E.P. 535,662, 17.4.41. Appl., 12.10.39.—Process of cracking high-boiling hydrocarbon oil to produce gasoline-like products. The oil is subjected to treatment with liquefied normally gaseous saturated hydrocarbon solvent, preferably propane. Thereafter the paraffinic constituents are separated from the solvent and subjected to an elevated temperature in the presence of a cracking catalyst to convert them into relatively high anti-knock gasoline-like products. The non-paraffinic constituents also obtained are subjected to a relatively high cracking temperature in the absence of a catalyst to convert them by pyrolytic cracking into lower-boiling hydrocarbons comprising gasoline-like constituents. These gasoline products are recovered and finally blended with the other gasoline-like products obtained.

Standard Oil Development Co. E.P. 535,895, 25.4.41. Appl. 19.9.39. Production of high knock rating gasoline from heavy hydrocarbon oil by heating the oil to a cracking temperature between 850° and 1000° F. and thermally converting a substantial proportion thereof into gasoline. The heavy residue is then separated from the cracked vapours, and the latter cooled to a temperature within the range 700–800° F. and contacted with a mass of desulphurizing catalyst. Finally the treated vapours are conducted to a fractionating zone, where separation of gasoline from unconverted heavy oil is effected. The latter is then recycled to the cracking zone.

W. Kaplan. U.S.P. 2,240,160, 29.4.41. Appl. 26.8.35. Method of cracking residue oils in the vapour phase by injecting them into a high-temperature stream of hydrocarbon vapour passing through a long tube of restricted cross-section mounted in a heating zone. The residue is intimately sprayed into the stream and in such a ratio to the stream that it is instantly vaporized. The heating of the stream is controlled and maintained above the dew-point of the mixture, and the process continued for a sufficient period of time to convert a substantial proportion of the oil residue into constituents boiling within the gasoline range. H. B. M.

Hydrogenation.

736. Hydrogenation of High-temperature Tar from By-product Coke Ovens. H. H. Storch, I. L. Hirst, C. H. Fischer, H. K. Work, and F. W. Wagner. *Industr. Engng Chem.*, 1941, **33**, 2, 264.—Industrial aromatic solvents can be produced by the hydrogenation of high-temperature coke-oven tar. Catalytic hydrogenation is effected in two stages: liquid-phase hydrogenation at 450° C. with 2 hr. contact time, followed by a vapour-phase hydrogenation at 510° C. with 0·5 min. contact time. Details of the various experiments carried out to investigate the variables—catalyst, contact time, conversion, and character of products—are given. The aromatic solvents produced by this process possess high solvent power and will be of value in the resin and lacquer industries. J. W. H.

Synthetic Products.

738. Synthetic Hydrocarbons. A. E. Williams. *Engineering*, 1941, **151**, 394.—A description of the Fischer–Tropsch process for the synthesis of hydrocarbons and carbon monoxide and hydrogen derived from coal or natural gas is given. The effect of pressure on the yield and character of the products is discussed, and details of loss in catalyst activity and a gas desulphurisation process are given. J. W. H.

739. Physical Characteristics of Synthetic Rubbers. J. N. Street and J. H. Dillon. *J. appl. Physics*, 1941, **12**, 45.—The nature and application of the more important types of synthetic rubbers are discussed. Summarized physical properties are given, together with the results of comparative tests in the following specific fields of application: motor-car tyres, petrol, oil and ozone resisting rubber-wear.
J. W. H.

740.* Properties of Synthetic Lubricating Oils. Synthesis and Properties of 11-normal-decyldocosane. S. Klos, E. Neyman-Pilat, and S. Pilat. *J. appl. Chem. U.S.S.R.*, 1940, **13** (a), 1369–1374. Translated by A. A. Boehtlingk, *For. Petrol. Tech.*, Nov.–Dec. 1940, **8** (11–12), 438.—The difficulty encountered in the separation of individual chemical compounds from lubricating oils induced the authors to prepare synthetically a number of hydrocarbons similar to those of petroleum oils. Numerous determinations of the molecular weights carried out by one of the authors had indicated that saturated hydrocarbons containing more than 30 carbon atoms in the molecule may have properties similar to those of lubricating oils. On the basis of this fact, the authors chose as the first object of their experiments one of the *iso*-hydrocarbons of the fatty series with 32 carbon atoms in the molecule—viz., 11-*n*-decyldocosane.

This report gives a detailed account of the synthesis and properties of this hydrocarbon. B. M. H. T.

Refining and Refinery Plant.

741.* Functions of Refrigeration in Petroleum Refining. W. R. McGinnis. *Refiner*, May 1941, **20** (5), 143–146.—With some exceptions, refrigeration is used in the refinery to provide control of chemical reactions or to remove certain components, a large part of the original material then going to further processing at higher temperature, or to a storage at atmospheric temperature. In such cases the cooled material is available to precool incoming material by heat interchange, reducing the amount of direct refrigeration required.

A number of refrigerants are available, and may be selected according to their suitability for the conditions under which they are to operate.

The most commonly used is anhydrous ammonia, which may be used either with compression or absorption cycles. Ammonia is suitable for temperatures ranging down to −80° or −90° F. The pressures are moderate, leakage is easily detected, and fire hazard is but little. It is not a diluent for lubricating oil, therefore lubrication of compressors is not a difficult problem. Ferrous materials are inert to ammonia, but copper-bearing alloys are subject to corrosion by ammonia.

Propane, which shows a flatter pressure–temperature curve than ammonia, fre-

quently is used, particularly in propane dewaxing systems as a diluent, and, by evaporation from the solution, as a direct refrigerant. Propane is also used in the conventional compression cycle.

Carbon dioxide is used for some special processes, but is not in general use. It requires equipment construction for high pressure and more power than that required for commonly used refrigerants.

Liquid sulphur dioxide is used in the Edeleanu process for solvent separation and also as a direct refrigerant by evaporation from the mixture. It is not ordinarily used below −20° F. In some cases, where lower temperatures are required, an indirect refrigerating system using a suitable refrigerant is employed. Sulphur dioxide with water is corrosive to ferrous materials, and must therefore be perfectly dry in the refrigerating system. Leakage absorbs water from the atmosphere, causing some external corrosion.

Freon 12 and Freon 11 are generally used for air-conditioning applications, being non-toxic, non-corrosive, and non-inflammable; but they may be used for other purposes where these qualities are desirable. Freon 12 is a moderate pressure refrigerant suitable for piston compressors, and standard equipment is available in a large range of sizes. Freon 11 is a low-pressure refrigerant, particularly suitable for centrifugal compressors, because of its large vapour volumes. In addition to the above refrigerants, ethane and ethylene are being used for low-temperature applications.

The power required to produce refrigeration at any definite condition of evaporator and condenser temperatures is not affected to any considerable extent by the selection of refrigerant; the power being nearly the same for the commonly used refrigerants at ordinary temperatures, except CO_2, which is not frequently used.

Details of design and principles of absorption refrigeration systems are given.

A. H. N.

742.* First Hydroformer Unit Put on Stream. J. V. Hightower. *Refiner*, May 1941, **20** (5), 153–156.—The process of hydroforming differs from thermal reforming in three respects. In the first place it is catalytic rather than thermal. In the second place it involves circulation of hydrogen in admixture with the heated fresh charge as the mixture passes over the granular catalyst. Finally, the gasoline produced is less olefinic, chemically speaking, than gasoline of the same octane number produced by thermal reforming, and has an appreciably higher content of aromatics—45–50 vol.-%.

The unit brings about an interesting conversion of the low-grade naphtha used as a feed-stock. There is an apparent paradox in the use of hydrogen produced in the operation, for it might seem that this gas would cause the process to be essentially one of hydrogenation. Such is not the case, however. The net result of the operation is to remove a portion of the hydrogen from the naphtha feed. As the feed passes over the catalyst after leaving a preheating furnace, the catalyst causes a chemical change, resulting in the splitting off of hydrogen atoms. By introducing a given quantity of recycled hydrogen into the chamber under definite conditions of temperature and pressure, the rate and nature of the chemical change produced by the catalyst are controlled, so that the production of unsaturated hydrocarbon materials is held to a minimum. This is a point of considerable difference between hydroforming and thermal reforming, since the gasoline made by thermal reforming contains a higher percentage of unsaturated materials. Because of the low rate of production of unsaturates in the hydroforming process, the rapid formation of heavy, tarry material on the surface of the catalyst is avoided and the activity of the catalyst prolonged.

The paper describes the operation of the first unit put up in Texas City.

The hydroforming process is capable of producing gasoline of aviation grades, although as operated at present the unit at Texas City is making motor fuel only. Octane rating of the gasoline may be raised by altering operation conditions.

The fact that there is a large amount of toluene in the gasoline is of importance. On the basis of charging 7500 brl. daily of naphtha feed, it is estimated that the potential toluene production of the hydroformer amounts to about 5,000,000 gal./year, approximately a fourth of the total toluene produced in the United States

during 1939. It is readily apparent that the installation of a few large units provided with equipment necessary for the recovery of nitration-pure toluene could meet any conceivable need for toluene for military purposes. A. H. N.

743.* Fractionation and Condensation Recover Distillate from Doctor Solution. Anon. *Refiner*, May 1941, **20** (5), 157–158.—Recovery of distillates from spent doctor solution is being accomplished through a series of heaters, flash and fractionating chambers, and a water-cooled vapour condenser. Since the solution is used at a once-through contact, pumped from the supply tank to the distillate contactors, settling drums and spent storage, the partly emulsified solution entrains a substantial quantity of the treated gasoline that is not broken out in the settling tanks. The recovery system is connected into the transfer line which leads the spent doctor from the settlers to the receiving tank, and consists of a steam-heated doctor heater, a combination flash, heating and stripping column, and a water-cooled condenser for recovered vapours mounted above an accumulator drum. The spent doctor is then led to the same tank as before, from which it is subsequently recirculated through a regeneration unit for reconditioning.

The plant is described in detail. The steam used to heat the doctor solution in the first heater and in the base of the flash-stripper column is taken from the plant main, but is not super-heated. The temperature maintained on the stream of doctor through both heaters is approximately 215° F., above the boiling point of water but below the boiling point of the doctor solution itself. Pressures maintained through the system are as near atmospheric as possible, so that the distillate in the doctor solution will distil without the hindrance of back pressure. A. H. N.

744.* Compressor Losses Caused by Orifice Meters. J. G. Burnham and V. E. Middlebrook. *Refiner*, May 1941, **20** (5), 167–169. *Paper Presented before Natural Gasoline Association of America.*—The effect of an orifice inserted in a line carrying gas will be to produce a final downstream pressure which is lower than the upstream pressure.

In the case of an orifice meter, which is usually installed relatively close to the compressor suction header, the final downstream pressure will be essentially the intake pressure of the machines. If there were no orifice in the line, the upstream or higher pressure, not the final downstream pressure, would then take to the machines.

If the orifice plant is eliminated, one of the following conditions will prevail: (1) The machine will handle more gas, due to an increase in volumetric efficiency, or (2) less horsepower, either total or per million, will be required to boost the same volume to a specified discharge pressure.

For the case given in this paper, of a 12-in. line carrying 3000 M.C.F. of gas available at 8-in. vacuum, the percentage of volumetric capacity lost will range from 1% at 5 in. differential to 15% at 50 in. The percentage increase in H.P./M.M.C.F. required to boost to 40 lb. varies from about 1% at 5 in. to 11% at 50 in.

If the orifice is removed from the master meter, the total incoming gas volume can be determined by two meters; one installed on the absorber residue, the other on the stabilizer tops. A factor calculated from a fractional analysis of the finished product may be used to convert the gallons of stabilized gasoline into equivalent cu. ft. of gas. The total of the two metered volumes plus the factored volume will equal the volume of gas entering the plant. A. H. N.

745.* Performance of Bubble-plate Columns. W. D. Harbert, E. S. Homan, D. D. Rosebery, and R. L. Huntington. *Refiner*, May 1941, **20** (5), 170–174.—There are two principal factors which determine the capacity of a bubble-plate column, such as a fractionator or an absorber: (1) The maximum quantity of liquid which can be passed downward through the downspout; (2) the maximum quantity of vapour or gas that can be passed upward through the bubble-plate.

Both of these maxima are fixed by the limit above which the column will no longer function in a normal manner. These two fluids—*i.e.*, the downward-flowing liquid and the upward-flowing vapour—are mutually interdependent on each other, in so far as their performance in the tower is concerned.

The counter-current flow of air and kerosine has been observed in several plate-to-plate sections of a 12-in.-inside-diameter bubble-tray tower under a wide range of liquid and gas-flow rates. It has been found that the ability of a downspout to disengage vapour from the frothy mixture flowing from the tray above determines in a large measure the gas and liquid capacity of a tower. Froth heights in the downspouts may vary considerably without the occurrence of priming or flooding; however, on the trays themselves it was seen that once froth began to build up, there was no stopping until the entire plate-to-plate section was filled with a frothy fluid mixture, whereupon the tower ceased to function counter-currently.

Reference is made to similar work carried out by Souders and others, and it is concluded that the behaviour of the flow of the liquid and froth in the downspout conformed closely to the mechanism described by these previous workers.

A. H. N.

746.* Y.P.F. Enlarges Capacities of Three Refineries. J. P. O'Donnell. *Oil Gas J.*, 20.3.41, **39** (45), 28.—The three refineries of the Y.P.F. at La Plata (near Buenos Aires), Salta (North Argentine), and Mendoza (in West Argentine) are being considerably enlarged. At La Plata a vis-breaker handling 5000 brl. per day of 13·5° A.P.I. cracked fuel oil or a 7 : 3 mixture of heavy fuel and asphalt is being installed. A distinctive feature of the plant is the generation of steam from water, preheated by waste heat from the circulating fuel oil, in the convection section of the heater, 10,000 lb. of 190-lb. gauge steam at 386° F. being produced daily.

At Salta a 2000-brl.-per-day combination topping and cracking unit operating on Rio Pozcado and Vespucio crude has been installed. (The San Pedro crude from Vespucio is of 45·5° A.P.I. with a paraffin base, and has an unusually high gasoline content.)

At Mendoza a 3200-brl.-per-day combination topping, vis-breaking, and cracking unit operating on Tupungato and Cachueta crude has been installed. (The Tupungato crude has a paraffin base, and gravity 30·2° A.P.I., and the Cachueta crude is mixed base of slightly higher gravity.) At the present rate of increase of refining capacity the country should be entirely self-sufficient in a few years. C. L. G.

747. Petroleum Refineries, including Cracking Plants, in the United States. 1st January, 1941. G. R. Hopkins and E. W. Cochrane. U.S. Bureau of Mines, Information Circular No. 7161. April 1941.—Statistics compiled by the Bureau of Mines, and included in this report in the form of summary tables, indicate that during 1940 the number of refineries in the United States increased from 557 to 562. This slight gain was maintained in spite of the fact that a number of plants were dismantled in Texas and other States.

Approximately 50 refineries closed down during the year, largely owing to low gasoline prices, competition for crude-oil supplies, and the termination of a favourable distributing arrangement for independent plants in the Los Angeles area. This was reflected in the number of operating plants, which declined from 461 to 420, and in the number of idle plants, which increased from 86 to 136.

Equally, operating capacity declined from 4,196,694 brl. daily on 1st January, 1940, to 4,180,588 brl. daily on 1st January, 1941, and idle capacity increased from 431,952 brl. to 538,381 brl. during the year. Even so completed capacity was 2% more on 1st January, 1941, than in the previous year.

Of the ten refining districts, four showed declines in total capacity. The largest gains were reported in the East Coast and the Texas Gulf Coast.

Completed cracking capacity again increased by 5%, and idle capacity decreased to the low level of 82,042 brl., of which 85% was reported to be in "good shape."

H. B. M.

748. Patents on Refining and Refinery Plant. Universal Oil Products Co. E.P. 535,656, 17.4.41. Appl. 14.9.39.—Process for separating a stream of conversion products essentially consisting of relatively heavy normally gaseous hydrocarbons, lighter gases, and hydrocarbons boiling within the gasoline range into more than three fractions of different composition.

Standard Oil Development Co. E.P. 535,664, 17.4.41. Appl. 16.10.39. Process of contacting hydrocarbons with mineral acids under conditions which cause degradation of the acid, and in which a requisite acid strength is maintained by replacing part of it with fresh acid. The invention relates specifically to the reaction between isoparaffins and olefins when it is customary to employ a high ratio of acid to olefin and to recover the product by withdrawing a portion of the reaction mixture containing acid, reaction product and unreacted material, allowing the mixture to settle to an acid layer and a hydrocarbon layer and returning the acid to the system.

Houdry Process Corp. E.P. 535,803, 22.4.41. Appl. 11.9.39. Treatment of heavy hydrocarbons, including tarry and asphaltic bottoms and similar hydrocarbon residues, to separate the same into solid and fluid parts. The invention is characterized by controlling the operating conditions, so that the temperature of the coking zone does not fall below 800° F. nor rise above 950° F.

E. H. Records and J. E. Louttit. U.S.P. 2,239,859, 29.4.41. Appl. 16.8.38. Refining hydrocarbon oils containing sulphur compounds by treating with a catalyst, including a metal salt selected from the group consisting of ferric chloride, aluminium chloride, and a dispersing agent, consisting of sulphonated castor oil, at an elevated temperature. The sulphur compounds are thus converted into soluble form.

R. Rosen and C. A. Cohen. U.S.P. 2,240,577, 6.5.41. Appl. 4.6.38. Method of separating and recovering constituents of petroleum products by intimately contacting the product in liquid form with an alkyl ester of citric acid, in circumstances permitting development of a two-phase liquid, and separating the two phases by gravity. H. B. M.

Chemistry and Physics of Petroleum.

749.* Recent Progress in Chlorination. E. T. McBee and H. B. Hass. *Industr. Engng Chem.*, 1941, **33** (2), 137.—Recent progress (1937–1940) in the chlorination of hydrocarbons is reviewed, and some of the recent discoveries are discussed. Among these discoveries may be mentioned the substitutive chlorination of olefines, peroxide-catalyzed chlorinations with sulphuryl chloride, chlorinations in intimate contact with a liquid mass of metallic chlorides, preparation of polychloropropanes, chlorination of natural gas, chlorination of aromatic compounds, chlorinolysis of paraffin hydrocarbons, high-pressure chlorination of paraffin hydrocarbons, hexachloroethane as a chlorination agent, the use of a capillary for introducing chlorine into material to be chlorinated, chlorination of esters, and chlorination of rubber. H. E. T.

750.* Synthesis of Phenol by Partial-Pressure Evaporation. D. F. Othmer and C. E. Leyes. *Industr. Engng Chem.*, 1941, **33** (2), 158.—Phenol has been synthesized by partial-pressure evaporation methods in both the sulphonation and fusion steps.

Benzene is sulphonated in the presence of a high-boiling naphtha fraction; then the sodium benzene sulphonate is neutralized and fused with caustic soda under kerosine. In each case the water of reaction or of solution is removed by partial-pressure evaporation. A comparison with other sulphonation methods is included, and the technical and economic advantages of this process (Kokatnur) are indicated. For the Kokatnur process good yields and low process costs are the principal merits. It is shown that the primary sulphonation step in the manufacture of phenol can be carried out with the theoretical molecular ratios of benzene and sulphuric acid, whereas in the fusion operation, aqueous caustic solutions and aqueous solutions of sodium benzene sulphonate can be employed directly, also in practically theoretical proportions.

High-speed (1000 r.p.m.) emulsifying stirrers with naphtha cuts boiling in the range 170–200° C. gave optimum results in sulphonation with either 94% or 98% sulphuric acid. Sulphones were not formed unless a large excess of benzene was employed. The small amount of charring which occurred was completely removed during neutralization.

The best results in the secondary, or fusion stage, were obtained with 50% aqueous

caustic soda (1·5% excess) and of sodium benzene sulphonate. In this case also high-speed emulsifying agitators were employed, allowing a reduction in the volume of kerosine and giving a sintered, readily soluble product. Exclusion of air during the fusion stage prevented oxidation of the sodium phenolate, an added attraction for the process. H. E. T.

751.* Aromatic Mercuration. K. A. Kobe and T. F. Doumani. *Industr. Engng Chem.*, 1941, **33** (2), 170.—Mercuration is of sufficient general application and importance in the aromatic series to be regarded as a typical substitution reaction, like nitration, sulphonation, or halogenation.

In general mercuration proceeds easily, with formation of mono-, di-, and poly-mercurated compounds. The ease of formation of di- and poly-mercurated compounds in many cases makes the formation of mono-mercurated compounds extremely difficult, so that the formation of mono-mercurated compounds in satisfactory yield by direct mercuration is impossible. The various methods for direct mercuration have been tabulated for hydrocarbons, amines, phenols, acids, nitro-compounds, and heterocyclic compounds. In addition, the various indirect methods of mercuration are mentioned. H. E. T.

752.* Utilization of Polychloropropanes and Hexachloroethane. E. T. McBee, H. B. Hass, T. H. Chao, Z. D. Welsh, and L. E. Thomas. *Industr. Engng Chem.*, 1941, **33** (2), 176.—A new term, "chlorinolysis," has been proposed to describe the process of chlorinating an organic compound under conditions which rupture the carbon–carbon bonds and yield chlorocarbons with a smaller number of carbon atoms than were contained in the starting material. The term "chlorinolysis" is analogous to the familiar terms hydrogenolysis, hydrolysis, alcoholysis, and ammonolysis.

Chlorinolysis of polychloropropanes has been carried out in a nickel apparatus in the temperature range 300–360° C. at a pressure of 1250 lb. per sq. in. Nickel has little effect on the dechlorination of partly chlorinated hydrocarbons and subsequent polymerization of the chlorolefines to carbonaceous material. The reaction temperature may be varied considerably, but below 300° C. substitution occurs very slowly, whilst above 400° C. undesirable side reactions take place. There also appears to be no limiting pressure, except that imposed by the material of which the apparatus is constructed.

The chief product obtained from the chloronolysis of propane and chlorides of propane was octachloropropane in good yield.

A careful investigation of the pyrolysis of octachloropropane was then undertaken, and the main products produced were carbon tetrachloride and tetrachloroethylene.

In addition, hexachloroethane and 1 : 2-dichloropropane were pyrolized to obtain useful products in good yield. H. E. T.

753.* Chloronolysis of Chloropentanes. E. T. McBee, H. B. Hass, and E. Pierson. *Industr. Engng Chem.*, 1941, **33** (2), 181.—High-temperature, high-pressure chlorination of chloropentanes has resulted in the formation of hexachloroethane, carbon tetrachloride, and hexachlorobutadiene. Explosions during the chlorinolysis of the chloropentane are prevented by use of excess chlorine. At 400° C. and under a pressure of 1000 lb. per sq. in. the conversions into carbon tetrachloride and hexachloroethane are approximately 90%, and the potential yield of these products approaches the theoretical value. H. E. T.

754.* High-Pressure Chlorination of Paraffins. E. T. McBee, H. B. Hass, and J. A. Pianfetti. *Industr. Engng Chem.*, 1941, **33** (2), 185.—Liquid phase chlorination of paraffin hydrocarbons yields a higher percentage of primary substitution products than are obtainable in vapour phase at the same temperature. Thus, in the thermal chlorination of paraffin hydrocarbons, high pressures may be desirable in order to obtain a liquid phase. In vapour-phase chlorination of saturated hydrocarbons increased pressure causes increased relative rates of primary substitution. Since there appears to be a direct correlation between the change in the relative chlorination rate and in the molar volume of the hydrocarbon with increasing pressure, it

appears that pressure alters the relative chlorination rate by effecting a greater absolute concentration of the hydrocarbon in the vapour phase.

The effect of temperature and pressure on the relative chlorination rates of hydrogen atoms in propane, *n*-pentane, and *n*-heptane carbon has been fully investigated; the temperature range being 150–200° C. and the pressure range 250–4000 lb. per sq. in. H. E. T.

755.* Relation between Free Energy and Structure of Organic Molecules. P. F. Bruins and J. D. Czarnecki. *Industr. Engng Chem.*, 1941, **33** (2), 201.—Equations are derived from existing molecular free-energy equations to express the amount by which the free energy changes on the formation of the following bonds: C–H, C–C, C=C, C–CH_3, C–OH, C–CHO, and C–CO_2H. The value of the atomic linkage equations, compared with the general free energy equations, which are expressed as a function of the number of carbon atoms in the molecule, is that the bond equations are not restricted to a single homologous series, but have a more extended application in thermodynamic calculations. J. W. H.

756.* Generalized Equation for Activity Coefficients of Gases. S. H. Marron and D. Turnbull. *Industr. Engng Chem.*, 1941, **33** (2), 246.—In a recent article in *Industr. Engng Chem.*, 1941, **33**, 69, the authors showed that the activity coefficients of gases can be calculated from an approximate form of the Beattie–Bridgeman Equation of State, if the constants are known. Newton (*ibid.*, 1935, **27**, 302) has shown that all gases under similar conditions of reduced temperature and pressure have the same activity coefficient. The present paper serves to correlate the two ideas by deriving an activity coefficient equation from the Beattie–Bridgeman equation in which the only variables are reduced temperature and pressure. J. W. H.

757. Infra-Red Spectra of Rubber and High Polymers. W. C. Sears. *J. appl. Physics*, 1941, **12**, 35.—The transmission spectra of thin films of crude rubber, soft and hard vulcanized rubber, thermoprene, polyvinyl chloride, neoprene, and pliofilm have been measured in the 2–15 wave-length band. The spectrum of rubber resembles the long-chain paraffins more closely than any of the other polymers. The polymers containing chlorine have distinctive spectra. J. W. H.

758. Heat of Wetting of Wood Charcoal by some Common Liquids. R. L. Razouk. *J. phys. Chem.*, 1941, **45** (2), 179.—Measurements were made of the heat of wetting of four samples of charcoal by water, methyl, ethyl, *n*-propyl, *n*-butyl, and *iso*butyl alcohols, benzene, pyridine, and carbon tetrachloride. The apparatus was so arranged that the charcoal could be completely outgassed before the determination. The measurements were made at 25° C. and 30° C. Observations were also made on the time required for the development of the full heat of wetting for the thoroughly outgassed charcoal. This was found to vary from a few minutes for water and methyl alcohol, up to 30 min. for benzene.

An account is given of previous work and of the various theories of wetting. P. D.

759.* Studies on the Separation of Paraffin Waxes. Part IV. The Sweating of Wax-Oil Mixtures. M. F. Sawyer, T. G. Hunter, and A. W. Nash. *J. Inst. Petrol.*, 1941, **27** (210), 143–154.—A previous paper indicated that an investigation of the factors affecting the efficiency of the sweating process in which the same oil and wax-stock and also the same sweater are used throughout, resolves itself into a consideration of the effects of the following variables:—

(1) Amount of oil in the oil–wax mixture.
(2) Rate of sweating.
(3) Rate of extent of cooling of the oil–wax mixture before commencing to sweat, and
(4) Viscosity of the oil.

These factors are here considered. It is shown that—

(1) The sweating of an oil–wax mixture is considerably easier to control than the fractional melting of an oil-free wax, a fact of particular industrial importance.

(2) The yields of the various melting-point waxes, calculated as a percentage of the wax content of the oil–wax stock, are considerably lower than for the corresponding waxes, and obtained by the fractional melting of the oil-free wax stock at the same rate;

(3) Under the same conditions of sweating, the efficiency of the process is dependant on the oil content of the stock.

(4) Rate and extent of cooling of the sample prior to sweating have little effect on the yield and oil content of the various waxes produced.

(5) For corresponding melting points, the yields of waxes obtained by sweating at 5% and 10% per hour are similar, but those from the faster process are of slightly higher oil content.

(6) In the limited experimental work performed on viscosity, results indicate that oil of higher viscosity is more difficult to remove from the wax, and the resulting wax is therefore of higher oil content. B. M. H. T.

Analysis and Testing.

760.* Improve Pharmacopoeia Tests for Petroleum Products. Anon. *Nat. Petrol. News*, 1941, **33** (6), R-47–48.—Changes in tests for the 12th revision of the U.S.P. are now under consideration. Proposed versions for a number of these concerning petroleum products are given. For paraffins, the m.-p. range is widened to 47–65° C., and the A.S.T.M. method recommended for their determination. In the test for carbonizable substances the strength of the acid and the manipulative details of the method are more rigidly defined. Allowance is made for the possible formation of paraffin/sulphuric acid emulsions in the matching of the colour produced against the standard.

A broader range for petrolatum is also recommended, the sp. gr. range widening to 0·815–0·865 at 60° C., and m.-p. range to 38–60° C. The A.S.T.M. method is proposed for m.-p. determinations.

In the case of liquid petrolatum, proposals include the substitution of the A.S.T.M. viscosity conversion table for that in use at present, the replacement of the term "opalescent" in the test for solid paraffin by the definition "Newsprint viewed through the diameter of the test-tube containing liquid petrolatum should be readable," and more rigid definitions of the details of the test for carbonizable substances. T. T. D.

761.* Mobile Unit for Studying Condensate Recovery. H. M. Nelly, Jr., and M. Benedict. *Refiner*, May 1941, **20** (5), 159–163 (cf. also *Oil Gas J.*, 8·5.41, **39** (52), 73).—When the type of equipment described in this article is run on the feed for the commercial unit, utilizing the same type of process at the same temperature and pressure, the results will be directly comparable with those which would be obtained in the commercial unit, thus eliminating all uncertainties in equilibrium constants. Furthermore, the products obtained will have the same characteristics as those which will be produced by the commercial installation.

The unit is a complete recovery plant mounted on a truck, which can be driven to a point where the high-pressure condensate stream to be studied is available. It has been so designed that it can be operated in any one of the following three conventional types of recovery processes:—

Atmospheric temperature absorption. Low-temperature absorption. Low-temperature separation.

The unit can be operated over the following range of variables: Well-head pressure: up to 6000 lb./sq. in. Primary tower pressure: up to 5000 lb./sq. in. Primary tower temperature:—10 to +120° F. Feed rate: 500–1200 Standard cu. ft./hr. Lean Oil rate: 0 to 5 gall./hr.

The units proper—*i.e.*, the towers, piping, valves, and meters—are located in the rear compartment of the truck body. Forward of these is the control compartment,

in which are mounted instruments for the measurement and automatic control of pressures, temperatures, liquid levels, and rates of flow. In the front compartment is located the equipment for providing utilities. This equipment consists of an air-cooled gasoline engine, which is the prime mover for the unit, generator, lean-oil pump, air compressor, and refrigerating apparatus. It should be noted that the unit is entirely self-contained and requires no external utilities.

The control of the operation of the unit has been made as nearly automatic as possible. This results in even operation and reduces the operating personnel to a minimum.

To illustrate the type of information which can be obtained from the operation of the unit, the results of two typical test-runs are presented. Both tests were absorption runs made on the same feed under identical operating conditions, with the exception of the temperature of the absorber. The operating conditions and principal results of these runs are given in outline.

The accuracy of the results obtained from the unit depend not only on its operation, but also on the ability to collect a representative sample, to transport it without leakage or contamination to the laboratory, and to analyse it correctly. There are certain checks which can and should be made before the data are accepted.

A. H. N.

Motor Fuels.

762. Patents on Motor Fuel. C. E. Every. E.P. 535,768, 22.4.41. Appl. 19.9.39. Preparation of a fuel for use in internal-combustion engines consisting of an emulsion of water as the disperse phase and hydrocarbon oil as the continuous phase. An amino-compound soap is mixed with the hydrocarbon oil, water added to the mixture, and the whole agitated to form an emulsion.

Standard Oil Development Co. E.P. 535,975, 29.4.41. Appl. 24.10.39. Production of a gasoline of full boiling range—*i.e.*, about 80–410° F.—and of high octane number by separating the C_4 and lower hydrocarbons and reacting the heavier hydrocarbons to produce alkylated aromatics having a boiling range which complements that of the C_3–C_4 fraction previously recovered to yield a gasoline having a satisfactory distillation curve and high octane number.

L. C. Kemp. U.S.P. 2,238,860, 15.4.41. Appl. 15.8.39. Process for the conversion of natural gasoline hydrocarbons into high-octane motor fuel. Initially the gasoline is fractionated to separate therefrom fractions respectively rich in normal butane and *iso*butane and to produce a fraction of hydrocarbons mainly of higher molecular weight than butane. The normal butane fraction is then submitted to isomerization to produce *iso*butane. The fraction consisting of hydrocarbons of higher molecular weight than butane is converted to form olefin hydrocarbons, and the products of conversion fractionated to produce therefrom a fraction comprising C_3 and C_4 hydrocarbons, including olefins, also a high-boiling fraction comprising motor-fuel hydrocarbons of relatively high octane rating. Finally the C_3 and C_4 fraction is subjected to alkylation with the *iso*butane, and the products of alkylation fractionated to separate therefrom a fraction comprising hydrocarbons suitable as aviation motor fuel of high octane value.

G. Egloff. U.S.P. 2,240,134, 29.4.41. Appl. 21.3.40. Treatment of petroleum fractions to produce therefrom substantial yields of essentially paraffinic motor fuel having relatively high anti-knock value. An intermediate-boiling-range petroleum fraction is treated at an elevated temperature, and in the presence of a catalyst consisting essentially of a mixture of ferric chloride and aluminium chloride with a minor amount of hydrogen chloride, to produce a substantial yield of *iso*butane and normal butane. The *iso*butane and normal butane are then separated and the latter cracked at an elevated temperature and pressure to produce a substantial yield of olefinic hydrocarbons. The *iso*butane is alkylated with the olefinic hydrocarbons, and the products of alkylation fractionated to recover high anti-knock value gasoline.

F. R. Moser. U.S.P. 2,240,145, 29.4.41. Appl. 22.8.39. Production of a liquid fuel for compression ignition engines. Incorporated in the fuel is a small amount of

heteropolymeric ketone peroxides obtained by oxidizing a mixture of at least two ketones of different molecular sizes, one of which is acetone. The mixture has an average number of carbon atoms of not more than 8 and not more than 80% by weight of any one ketone. H. B. M.

Gas, Diesel and Fuel Oils.

763. Patents on Gas, Diesel and Fuel Oil. M. L. Chappell. U.S.P. 2,238,553, 15.4.41. Appl. 14.3.38. Method of increasing the cetane number of a petroleum diesel-oil fraction. The oil is treated with a diazonium salt at a temperature below 40° F. Thereafter the mixture is neutralized, and the water, containing dissolved salts of the reaction, separated from the diesel oil fraction.

C. Ellis. U.S.P. 2,240,558, 6.5.41. Appl. 7.2.36. Improving the ignition quality of a diesel fuel by mixing with dilute nitric acid in proportions ranging from about equal volumes of the diesel oil and acid to 5 vol. of oil to 1 of acid. H. B. M.

Lubricants and Lubrication.

764.* Trends of Lubricating Oil Manufacture and Utilization. M. H. Tuttle. *Refiner*, May 1941, **20** (5), 164–166. *Paper Presented before Western Petroleum Refiners Association.*—The trend to-day in the field of engine design continues to be towards higher temperatures and higher pressures, and this must continue, because this is in the direction of greater fuel economy. The limit is only that imposed by the materials for construction, the combustion characteristics of the fuels, and the lubricating characteristics of the oils. Since engines are now designed on the basis of the higher-quality oils, it becomes necessary for the manufacturers of the lower-grade oils to suit their product to the engine.

By the solvent treatment of properly selected stocks, oils of high viscosity index and of excellent stability can be produced. Additives should be employed to supplement deficiencies of the raw stock, and not to replace the best refining methods.

The value of the lowest viscosity oils now in use is questioned, but if their use is to be continued, it is proposed that extensive engine tests be conducted to determine the film-stabilizing effect of including in such oils solvent-refined residual fractions.

Before the advent of solvent extraction, lubricating-oil quality was almost entirely a matter of crude source. To-day oils of equal paraffinicity are produced without regard to crude source, although yield of paraffinic oil and resistance to oxidation are greatly affected by crude source. Little is known about this quality of some oils of high viscosity index to be more resistant to oxidation than others, but frequently high stability has been found together with high sulphur, which would indicate the presence in some crudes of sulphur-type oxidation inhibitors.

Since the high-yield stocks do not necessarily produce the most stable oils, it is important that the crude sources be investigated with regard to each of these characteristics. A. H. N.

765.* Extreme-Pressure Addition Agents. E. A. Evans and J. S. Elliott. *J. Inst. Petrol.*, May 1941, **27** (211), 165–180.—Patented additions to extreme-pressure lubricants may be classified generally into groups comprising sulphur, chlorine, phosphorus, and nitrogen compounds. The sulphur compounds may be sub-divided into derivatives of mineral oils, fatty oils, organic acids, esters, polymers, and a variety of specific aliphatic and aromatic compounds. Representative addition compounds from each of these groups were tested for film rupture strength in the Almen Machine, and the efficiency of the compound in promoting the load-carrying capacity of the oils in which they were incorporated assessed and discussed in relation to structure. B. M. H. T.

766. Patents on Lubricants and Lubrication. Standard Oil Development Co. E.P. 535,777, 22.4.41. Appl. 21.9.39. Preparation of an improved lubricating composition for use in internal-combustion engines, and comprising a mineral lubricating oil and small amounts of salts or soaps of at least two polyvalent metals selected from

the three groups consisting of (1) aluminium, (2) nickel, and (3) a group comprising the alkaline earth metals and magnesium.

A. H. Gleason. U.S.P. 2,238,638, 15.4.41. Appl. 23.12.37. Preparation of an improved lubricant consisting of a viscous waxy hydrocarbon oil containing a small proportion of a polymerized oxygen-containing aliphatic compound having an oxygen atom connected only to carbon and having a chain of more than ten carbon atoms. The polymer product contains a substantial proportion of fractions with a molecular weight above about 600, and soluble in the oil.

C. Clar, N. Geiser, and P. Kühnel. U.S.P. 2,238,846, 15.4.41. Appl. 9.8.37. Production of lubricating oils by catalytically hydrogenating carbon monoxide, cracking the non-gaseous hydrocarbons obtained, and converting the cracking products by means of a polymerizing agent, containing a substantial proportion of aluminium chloride, into lubricating oil. During the process it is found that the oils are improved by heating in the presence of the polymerizing agent to a temperature between 140° and 240° C., while excluding additions of halogenated hydrocarbons.

A. W. Lewis. U.S.P. 2,239,752, 29.4.41. Appl. 2.4.37. Lubrication of bearing surfaces having substantially the corrosion susceptibility characterizing cadmium–silver, cadmium–nickel, and copper–lead alloys. The lubricant employed consists of a mineral hydrocarbon oil to which has been added corrosion inhibiting proportions of benzo-nitrile.

E. W. Cook. U.S.P. 2,239,841, 29.4.41. Appl. 12.12.38. Method of lubricating bearing surfaces, at least one of which comprises an alloy having substantially the corrosion susceptibility of cadmium–silver, cadmium–nickel, and copper–lead alloys. The lubricant has incorporated therein an oil-soluble organic morpholine in corrosion inhibiting proportions.

M. Fairlie. U.S.P. 2,239,953, 29.4.41. Appl. 1.5.39. Preparation of a lubricating composition consisting of a petroleum lubricating oil and chlorocalcium phenyl stearate in which the chlorine is attached to the calcium.

D. E. Badertscher. U.S.P. 2,240,009, 29.4.41. Appl. 26.5.39. Preparation of a mineral-oil composition consisting of a viscous mineral-oil fraction and a minor proportion of the reaction product obtained by dissolving substantially equivalent proportions of an alkali alkyl xanthate and a β-chloroethyl amine in a suitable solvent medium. The mixture is refluxed for sufficient time to precipitate alkali chloride and form the reaction product. Finally the alkali chloride and the solvent are removed from the reaction product.

R. W. Richardson. U.S.P. 2,240,054, 29.4.41. Appl. 4.5.38. Method of improving and refining a lubricating oil by subjecting it to the action of more than 800 cu. ft. of air per barrel of oil at a temperature between 300° and 500° F. in the presence of 0·1% of manganese naphthenate. The air is passed through the oil at the rate of about 4½ cu. ft. of air per barrel of oil, per minute. The oxidized oil is thereafter treated with a solvent mixture to remove undesirable constituents.

R. E. Conary, H. V. Ashburn, and P. S. Stutsman. U.S.P. 2,241,243, 6.5.41. Appl. 25.3.39. Preparation of a lubricating oil comprising a mineral lubricating oil containing 0·01–2·0% by weight of a phosphite ester of an alkyl ether of an alkylene glycol. H. B. M.

Special Products.

767.* Useful Products From Natural Gas. F. H. Dotterweich. *Refiner*, May 1941, **20** (5), 147–152. *Paper Presented before Natural Gasoline Association of America.* The non-hydrocarbon constituents, with the exception of carbon dioxide, are found in natural gas in relatively small amounts. Hydrogen sulphide, which is objectionable, due in part to its corrosive nature, may be removed and marketed for agricultural uses. The extremely fine state in which the sulphur is recovered has special value both in liquid sprays and as a solid dusting material. Helium, although present in natural gas in small amounts, is nevertheless of great value, as an oxygen diluent

for medical purposes, inflation of lighter-than-air balloons and ships, as a preservative, and in the electric industry. Some wells produce carbon dioxide in relatively large amounts and make possible its recovery and use as a refrigerant, fire extinguisher, food preservative, and beverage carbonator.

The hydrocarbon groups of dry natural gas and bottle gas which are by-products of the natural gasoline industry must be converted into other products before they may be used to manufacture useful products. There are four methods of conversion: decomposition, oxidation, halogenation, and nitration. The four methods are discussed in some detail, with a study of possible products to be obtained commercially.

Synthetic rubber manufacture and utilization under various trade names is discussed.

Ethylene is an important raw material for many types of synthetic resins. This material used in the production of many plastics is obtained from cracked natural gas and refinery gas.

England, faced with a shortage of material for cable sheathing, in that polyvinyl chloride formerly imported from Germany was used for this purpose, has developed one of the latest type of plastics, polythene. This product is made by the direct polymerization of ethylene and possesses rubber-like qualities and excellent insulating characteristics.

Ethylene is the source of an important group of plastics based on vinyl chloride. Vinyl chloride may be manufactured from ethylene by the direct addition of hydrogen chloride to acetylene. In addition, and closely related to ethylene chloride is vinyl acetate. This compound is now chiefly manufactured from acetylene and acetic acid, the acetylene being produced from carbide; however, the future should see large quantities of acetylene, used in this process, produced from natural gas. These compounds, together with polyvinyl butyral, are being marketed and sold in varying proportions under the name of vinylite resins.

One of the most interesting and important applications of these resins is their use as Plexiglas. This product is one of the hardest acrylic resins, a colourless, transparent, thermoplastic solid. In addition, it may be obtained in a number of colours, both transparent and translucent, varying from delicate tints to the deep shades. The thermoplastic property of Plexiglas makes possible its fabrication at ordinary temperatures attained in ordinary ovens. By the use of wood tools, it may be readily machined. The optical and electrical properties of this substance are discussed.

The paper deals with an extensive number of products besides those mentioned above. A. H. N.

768.* Sulphuric Acid from Refinery Sludge. Anon. *Chem. Met. Eng.*, May 1941, **48** (5), 144–147.—The paper consists of a short descriptive part and a detailed flow-sheet, illustrated by photographs of an actual plant. When acid sludge is heated to 550° F. it decomposes into sulphur dioxide gas, solid coke, water vapour, and a small quantity of hydrocarbon gases. The sulphur dioxide can be processed in a contact sulphuric-acid plant to give clean sulphuric acid of any desired strength.

In the plant, the granular coke resulting from the decomposition of the acid sludge is fed in regulated quantity into a rotary kiln, where it is ignited and discharged at redheat into a second and smaller kiln by means of a sealed plunger feeder. The heat content of the coke is transferred to the sludge, which is fed into this second kiln in a measured and continuous stream, and the breakdown reaction is quickly completed. The strong gas from the decomposition kiln is cooled to condense out moisture and condensable oil, and then passed through the furnace, where any fixed hydrocarbon gas is burned out. The gas is then cooled, dried, and processed in a contact-acid plant using vanadium catalyst. The coke resulting from decomposition of the sludge is returned to the heating kiln after the excess has been diverted for use elsewhere. A. H. N.

769. Patents on Special Products. H. R. Fife. E.P. 535,588, 15.4.41. Appl. 12.10.39. Preparation of a petroleum composition for protectively coating or binding coal. The composition consists of a petroleum oil having a viscosity between 50 and 150 Saybolt seconds at 60–100° F., charged with added amorphous petroleum wax in such

quantity that the oil at least partly gels at room temperature, but remains capable of being sprayed.

H. R. Fife. E.P. 535,589, 15.4.41. Appl. 12.10.39. Method of protectively coating coke or coal by heating a mixture of petrolatum and water to liquify the petrolatum, and spraying the heated mixture on the fuel under combined extraneous pressure and vapour pressure within the heated liquids.

N.V. de Bataafsche Petroleum Maatschappij. E.P. 536,497, 16.5.41. Appl. 20.11.39. Catalytic treatment of hydrocarbons, consisting of or containing *cyclo*-paraffinic and/or *cyclo*-olefinic hydrocarbons, boiling substantially within the gasoline range. The invention particularly concerns the catalytic dehydrogenation of *cyclo*-paraffins and *cyclo*-olefins, or mixtures containing these hydrocarbons—*e.g.*, *cyclo*hexane, methyl *cyclo*hexane, and gasolines rich in or at least containing naphthenes, with the object of producing aromatic hydrocarbons.

P. J. Gaylor. U.S.P. 2,238,637, 15.4.41. Appl. 18.8.38. Preparation of an improved oil composition consisting of an insulating hydrocarbon oil and a soluble condensed polynuclear hydroaromatic compound having a molecular weight above about 200, also the property of lowering the viscosity index of the oil and its gas evolution under the influence of an electric discharge. H. B. M.

Detonation and Engines.

770.* Octane Rating Relationships of Aliphatic, Alicyclic, Mononuclear Aromatic Hydrocarbons, Alcohols, Ethers, and Ketones. G. Egloff and P. M. Van Arsdell. *J. Inst. Petrol.*, April 1941, **27** (210), 121–138.—This paper is largely a compilation of the octane ratings, scattered throughout the literature, of hydrocarbons, alcohols, ethers, and ketones.

The data are discussed in relation to the nine rules proposed by Lovell, Campbell, and Boyd concerning the relationship between structure and octane rating. For the pure hydrocarbons it was found necessary to modify somewhat their first and second generalizations, whilst considerations of data on the oxidized compounds showed that these rules were also applicable to the oxidized class of motor fuels. It is shown that the combustion conditions under which the octane ratings are made are the most vital factor in any octane rating given for a chemical compound. The octane ratings given for the various compounds and the generalizations made from them are specific for the test method indicated, and any change in the test method markedly alters the octane rating of the compound. B. M. H. T.

771.* Extension of the Octane Scale above 100 O.N. (Report and Recommendations of the Institute of Petroleum Knock Rating of Aircraft Fuels Panel.) Anon. *J. Inst. Petrol.*, May 1941. **27** (211), 188.—As some experimental types of fuel have anti-knock values better than that of pure *iso*-octane, it has been considered desirable to provide an extension of the octane scale. The scale recommended extends from the O.N. of reference fuel C + 4 mls./T.E.L. Imp. Gal. to that of F + 4 mls. T.E.L./Imp. Gal. (C 12 + 4 mls./Imp. Gal. = 93 O.N. approximately; F 3 + 4 mls./Imp. Gal. = 116 O.N). B. M. H. T.

772.* Tentative Method for Knock Rating of Experimental Aviation Fuels of Over 100 O.N. "17° Motor Method." (I.P.T. Serial Designation G. 396–194° (T). Anon. *J. Inst. Petrol.*, May 1941, **27** (211), 191.—The method is primarily intended for testing experimental types of fuel of over 100 O.N. The apparatus and method are as laid down under I.P.T. Serial Designation G. 39 (T), except that a fixed ignition setting of 17° early shall be used, and the bouncing-pin lower-leaf spring-tension increased to prevent the pin from bouncing as a result of higher combustion pressures. The spring tension may be increased if necessary for stable working up to a maximum of 300 gms. B. M. H. T.

773.* Calibration of C.F.R. Reference Fuels. Anon. *J. Inst. Petrol.*, May 1941, **27** (211), 192–194.—The calibration of F 3 + 4 mls. T.E.L./Imp. Gal. and C 12 + 4 mls. T.E.L./Imp. Gal. has been determined by the C.F.R. Motor Method (I.P.T. G. 39 (T) and I.P.T. G. 39(b) T), and continued up to 116 O.N. B. M. H. T.

774.* Liquid Jets of Annular Cross Section. A. M. Binnie and H. B. Squire. *Engineer*, 1941, **171** (4448), 236–238.—Experiments made on a water-jet produced by an annular orifice are described. An approximate theory of the form of the annular portion is derived and is compared with experimental observations. J. G. W.

775.* Tests of a Kadenacy High-Duty Moderate Speed Experimental Unit. S. J. Davies. *Engineer*, 1941, **171** (4448), 238–240.—The results of tests made on a two-stroke engine to which the Kadenacy principles of exhausting and charging had been applied are given. The unit had a bore of 4·515 in. and a stroke 6·5 in., and operated at 1000 R.P.M.

The output obtained was exceptionally good and the fuel consumption satisfactory; with a more efficient supercharger the performance would have been still more striking.

A high standard of reliability was shown on an endurance test, evidenced by the small amount of wear measured, the low consumption of lubricating oil, and the good conditions of the oil at the end of the run. J. G. W.

776.* Temperature and Latent Energy in Flame Gases. W. T. David. *Engineer*, 1941, **171**, 268–270.—Experiments are described confirming the view previously held by the author that the temperature rise resulting from the combustion of an inflammable gaseous mixture increases as the distance of flame travel from the igniting spark increases. This is ascribed to the difference between the mechanism of flame propagation in the early stages of combustion after spark ignition and that in the later stages.

Experiments are also described which show how the temperature attained by the flame gases resulting from the combustion of any given homogeneous inflammable mixture depends greatly on the manner in which combustion takes place. It is shown that under certain conditions, after careful allowance has been made for radiation losses, this temperature may be several hundreds of degrees C. below the calculated value. A theory is advanced to account for this discrepancy.

It is further shown that, owing to latent energy, the ideally calculated pressures are not fully attained in closed vessel explosions even after allowing for the heat loss which takes place during explosion. The measured explosion pressure was found more nearly to approach the ideally calculated value as the size of the explosion vessel was increased, suggesting that little success in determining the specific heats of gases by the explosion method can be expected unless very large vessels are used.

E. F. C.

777. Notes on Recent Developments in Fuel Technology. J. Hiles and J. R. Thompson. *Fuel*, XX, 1941, p. 61.—A brief review is first made of recent developments in the use of protective furnace atmospheres in the heat treatment of ferrous materials. Due to the extensive experience gained in recent years in atmosphere control, it now appears to be possible to produce any desired atmosphere with comparative ease and to conduct heat treatment of the metal without surface damage.

The method of colliery cleaning of anthracite next described consists of feeding the coal in at one end of a large rectangular tank containing a 1-ft. layer of water and underneath this a 2-ft. layer of a parting liquid. This consists of a mixture of pentachlorethane and ethylene dibromide with a sp. gr. of 1·70. As separation takes place, flight conveyors remove clean coal and refuse, which are then washed with water-sprays. Due to special arrangements to conserve the parting liquid in use, the consumption per ton of feed of pentachlorethane is only 8 oz. and of ethylene dibromide only 1 oz.

Experiments carried out with a C.F.R. four-stroke diesel engine in which the oxygen content of the charge could be raised from 21% to 55%, showed that with appropriate fuel injection the B.H.P. increased by 50%. At the same time the maximum cylinder pressure did not vary appreciably, whilst the maximum rate of pressure rise actually decreased up to an oxygen content of 45%. Ignition lag decreased linearly with increasing oxygen content, the lag with 55% oxgyen being less than half that with air. Since it appears that oxygen boost may safely be applied for short periods, it is suggested that the method might be applied to assist the take-off of diesel engined aircraft, so saving considerable engine weight.

E. F. C.

Coal and Shale.

778.* Oil-Shale Deposit of Orepuki, Southland. R. W. Willett and H. W. Wellman. *N.Z. J. Sci. and Tech.*, Sept. 1940, **22** (2B), 84B.—The results expressed in this report are based on information obtained from geological and geophysical surveys carried out in 1939–40. The Orepuki oil-shale lies at the eastern end of Te Wae Wae, Longwood Survey District, Southland. About 14,000 tons of oil-shale were mined and treated during 1899–1903, since which date the plant has been closed.

The rocks of the Orepuki have been divided into three groups. The igneous basal complex, which ranges from noritic to granitic types, is separated by a large unconformity from the shale-bearing Waimeamea Series. Both the above groups were folded and faulted, and suffered considerable erosion before the deposition of the Orepuki Series, which extends indifferently over both the bedrock and the Waimeamea Series, and is penetrated only by the larger streams of the district.

The oil shale occurs near the base of the Waimeamea Series directly overlying the workable coal-seams, and ranges in thickness in the known areas from 4 ft. 6 in. to 8 in. Further information is needed on the thickness of the shale over the entire region, which is only possible by drilling. Suggested drilling sites are indicated. Large-scale distillation tests show that on the average the oil-shale yields 43 gals. crude oil per ton and 26·7 lb. ammonium sulphate per ton. The average sulphur content of the oil shale is 5·9%.

The quantity of oil shale *in situ* lies between a probable maximum of 6,769,000 tons and a probable minimum of 1,770,850 tons. Mining conditions and the possible percentage recovery and probable cost are discussed. B. M. H. T.

Economics and Statistics.

779.* Oil in International Relations. Walter H. Voskuil. *Bull. Amer. Ass. Petrol. Geol.*, March 1941, **25**, 353–370.—The importance of petroleum to a nation is not to be gauged only by the demand for gasoline, fuel oils, or lubricants. Importance may also be gauged by critical needs, special functions, irreplaceable services more importantly than by quantity consumed only. Oil is a raw material vital to the welfare, industrial and military strengths of nations even to the very survival of nations. The paper illustrates and describes the various world oil-producing districts and consuming markets, the political impediments to free movement of oil, and some of the international tensions that have risen as a result of the fortuitous and *uneven* manner in which oil resources are distributed geographically and politically, and is of interest in view of the present international situation in Europe, etc. Maps showing imports into the countries concerned and their usual routes are given. In regard to Russia, the writer states that although she is the biggest producer of oil in Europe and has large reserves, exports of crude and refined products fell from 30% of production in 1932 to 4% in 1938, in spite of increase in crude production. Industrial development, military expansion, and mechanization of agriculture tended to absorb most of the Russian oil output. R. J. W.

780. Petroleum Engineering Education. H. H. Power, *Petrol. Tech.*, March 1941, A.I.M.M.E. Tech. Pub. No. 1312, 1–5.—Engineering colleges render considerable services by the progressive process of selection of career aims. It is essential to eliminate misfits, but enrolments should not be restricted so as to tend to create a group of very independant individuals who lack the incentive to make a record of their own.

The basic principles underlying the work cannot be thoroughly covered in four years, but it is doubtful whether five or six years would give proportional gains to many students. A tentative four-year course distributes time amongst subjects as follows: chemistry (21), engineering drawing (6), economics (3), English (12), geology (18), government (3), mathematics (14), physics (12), civil engineering (12), electrical engineering (3), mechanical engineering (8), petroleum engineering (22). The instruction in chemistry should cover physical chemistry and colloids; in geology it should have a sedimentary bias. Fluid mechanics and thermodynamics are essential. A sound basic training must be given, with an appreciation of the importance of cost and practical economics, and the student must acquire the ability to express himself clearly both orally and in writing. G. D. H.

BOOK REVIEW.

Exploration Geophysics. By J. J. Jakosky. Pp. xii + 786. Figs. 411. Printed by Times Mirror Press, Los Angeles, California, U.S.A. 1940. Price $9.00.

This is the second book on the subject of Geophysical Prospecting or Exploration Geophysics to make its appearance in this country in the past few weeks, and a third on the same subject, already published in U.S.A., may arrive here any day. Whatever the immediate cause for this spate of publication, it indicates at least the great importance which geophysics has attained in its application to problems of economic geology, especially in oil and mining exploration, and also a wide-felt need for a comprehensive and up-to-date book on the subject. Such an inundation might easily have produced some confusion, but from a consideration of the first two books, it is obvious, and indeed fortunate, that they each appeal to a different class of reader, although a certain amount of overlap is inevitable. The treatise by Jakosky is essentially a book for the practising geophysicist and reader actively interested in the application of geophysical methods. Furthermore, the earlier publication by Nettleton is limited to prospecting for oil, whereas this work covers all important economic applications in mining, water supply and civil engineering, in addition to oil prospecting.

The book is divided for the most part according to the geophysical method. Five chapters covering nearly three-quarters of the volume, deal successively and at considerable length with the older methods, grouped in the customary manner as magnetic, gravitational, electrical (two chapters) and seismic methods. Two short chapters are concerned with newer methods, the first with geo-chemical methods, the other with geo-thermal methods. One chapter of fifty pages is devoted to drill or borehole investigations, especially the measurement of electrical resistivities and potentials, which have achieved considerable importance in recent years, and a further chapter of twenty-eight pages discusses physical principles applied to oil production problems. The three remaining chapters apply to geophysical prospecting as a whole. In the introductory chapter the author presents a brief historical review of the development of geophysical methods from remote times up to the present-day, and proceeds to indicate trends in development of future methods. Chapter II, as set out in the caption, deals with the geological and economic background of exploration geophysics, and the last chapter of the book refers briefly to permit and trespass practice and insurance, mainly of concern and interest to geophysical parties operating in U.S.A.

The above brief outline indicates to some extent the comprehensive nature of this book. Not only is the whole field of economic geophysics covered, but each method is described and discussed in unusual detail, and no important aspect of the subject is omitted or neglected. The fundamental principles and theories, the instruments and equipment, the field techniques, reduction of observations and the final analysis and interpretation—all are given full and proper consideration. A particularly noteworthy and valuable feature of the book is the special attention given to the application of the various methods to specific problems of economic geology. The applications are well exemplified by illustrations, records, profiles, plans and maps, many of which are taken from actual field surveys. Suitable charts and diagrams and numerous photographs of instruments, equipment and field operations add greatly to the interest, value and clarity of the book as a whole. Instead of the usual bibliography, a list of patent references is introduced at the end of the appropriate chapter or section. As the author remarks, "Patent specifications . . . tend to be more authoritative than the reports in contemporary literature." Particular attention may also be directed to Chapter II, where the subjects discussed are all of prime importance in the economic and efficient application of geophysical methods to particular geologic problems. Being of a controversial nature, they are all too frequently overlooked or avoided.

Before concluding, mention may be made of one or two features which detract from the general high standard of the book. In various sections the arrangement or sequence is somewhat disjointed, due, it would seem, to a lack of uniformity in

the treatment of the various methods. This discontinuity is further emphasized by the fact that there is sometimes no differentiation in type to distinguish main from subsidiary headings. Throughout the text numerous paragraphs appear in inconveniently small closely printed type, for no obvious reason other than the condensation of the subject matter within the 787-page limit of this book.

This elaborate work by Jakosky is unquestionably the most comprehensive and detailed compilation on the subject of Exploration Geophysics which has yet appeared. It is brimful of valuable information, and is altogether a record achievement, for which the author deserves the highest praise.

J. C. TEMPLETON.

PUBLICATIONS RECEIVED.

Australia ; Council for Scientific and Industrial Research, 14th Annual Report, 1939–40. Pp. 102. Fcp.

The 14th Annual Report covers the entire field of research work carried out under the Council for Scientific and Industrial Research during the year ended 30th June, 1940. Most of the work relates to biological problems, but reference is made to researches on lubrication and wear under the direction of Dr. P. Bowden, of the University of Melbourne, formerly of University of Cambridge. It is believed that the results will be of considerable value in connection with the growth of the Australian aeroplane engine industry. A C.F.R. engine has been installed in the Aeronautical Research Laboratory. A new laboratory is being built for investigations in industrial chemistry.

Empire Mineral Resources and their Relation to the War Effort. Sydney J. Johnston. Institute of Chemistry, 1941. Pp. 85.

This is a reprint of the 23rd Streatfield Memorial Lecture, 1940. The author is Principal, Mineral Resources Department, Imperial Institute, London. The subject is dealt with under three main headings—viz., the Empire's share of mineral wealth; production, uses, and trade in Empire minerals; and Government assistance to the mining industry in the Overseas Empire. The statistical information relates to 1938, and constitutes a useful summary of the well-known annual *Mineral Industry* published by the Imperial Institute.

Stabilized Roads. R. H. Picher. Canadian Bureau of Mines; Technical Paper No. 800. 1940. Pp. 37.

This Report treats specially of the method of stabilization of graded granular soils with clay binder and moisture film. Brief mention is made of the use of Portland cement and several types of bituminous materials as permanent stabilizers.

B.E.A.I.R.A. 20th Annual Report. Oct. 1939–Sept. 1940. Published by the Association. 1941. Pp. 134.

Under the heading "Insulating Oils" it is stated that a report on the ageing tests of oils from several large power-stations over a period of years is in an advanced stage of preparation. The tests show that the sludge and acidity values of the oils have changed very little during the period.

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Geology and Development.

781.* Central Basin of Appalachian Geosyncline. Robert C. Lafferty. *Bull. Amer. Ass. Petrol. Geol.*, 1941, **25**, 781–825.—The Appalachian geosyncline comprises three major basins of deposition—namely, (1) a northern basin, with its deepest point near Altoona, Pennsylvania; (2) a central basin, having its deepest point near Elkins, West Virginia; (3) a southern basin, with its thickest sediments centred near Birmingham, Alabama. In his paper the author summarizes and critically examines existing information and opinion relative to the structure and stratigraphy of the *central basin only*.

A map is given, showing, by means of contours, relative sizes and shapes of the three major basins, with an outline of the central basin, represented by presently exposed Permian beds, also structural and depositional sections of two cross-sections at right angles to each other. The one from north-west to south-east is across the deepest part of the basin, the other, north-east and south-west, roughly paralleling the strike of the basin, thickness and areal distribution of the rocks being obtained from drilling records.

The author, in his summary, states that the accumulation of oil and gas in most of the silica sands in the central basin is primarily a matter of proper sand conditions, with anticlinal structure of secondary importance. Devonian shale-gas production is apparently related to the lower margin of an epi-continental shelf that helped to create a fracture-type reservoir.

Based on well records, the earliest indications of movements on the north-east–south-west anticlinal trends occurred during Medina time, and on the north–south trends movement apparently began in late Devonian. R. J. W.

782.* Sediments of Fresh-water Lakes. W. H. Twenhofel and V. E. McKelvey. *Bull. Amer. Ass. Petrol. Geol.*, 1941, **25**, 826–849.—This paper deals with the studies of lake sediments, largely limited to fresh-water lakes of the Upper Mississippi Valley, together with the published literature relating to lake sediments, and it is believed that most of the generalizations suggested have somewhat general application. Results so far obtained indicate that the sediments of each lake are, to some degree, of individual character.

Sediments are products of inheritance and environment, and this is true of the sediments of lakes, as of those of other realms of sedimentation. Sediments deposited

in lakes depend on many environmental factors, and combinations of these factors are almost infinite, probably being different for each lake and different in each lake from time to time. Characters of the sediments should reflect the combinations. Important factors of sedimentary control are the origins of the lake basins, size and depth of basins, relief of drainage areas, extents of shallow waters adjacent to shores, degree of vegetable protection over drainage areas, characters of surrounding rock and soil terrains, topography of bottoms of basins, circulation of lake-waters, climatic conditions, character of lake-water, sources of lake sediments. All these factors are considered in as much detail as seemed necessary.

Lake basins result from damming, excavation, and crustal movement. Damming is probably responsible for most basins and crustal movement for fewest. Size and depth of a basin may be related to origin, some of the largest and deepest being of structural origin. Lakes of glacial origin are of all sizes and depths. The largest and deepest of the glacial lakes are due to over-deepening and damming of pre-glacial valleys. Other glacial lakes, although maybe large, are mostly less than 100 ft. in depth. River lakes may attain great size, especially in length, but are usually shallow. Basins due to volcanic explosions may be of large size and great depth.

Under humid conditions, size and depth of a basin determine the size and depth of the lake therein, which in turn determine the strength of the waves and their attack on the shores and bottom and the character of the shore and bottom deposits. The greater the lake the more severe the wave action and the more vigorous and greater the erosion of the shores, giving much turbulence, which may result in high turbidity. With small lakes, waves are weak and wave attack on shores is small. Plants accordingly colonize shallow bottoms and shores. Whilst the inorganic sediments from shores are limited, organic sediments, brought to or deposited outward from the shores, are correspondingly greater. Deposition proceeds more slowly on large and deep lakes than on small, shallow lakes. Size and depth of lakes have a direct bearing on the extent of currents present, and are limiting factors where circulation is concerned. Processes of chemical deposition and diagenesis may be directly related to the size and depth of lakes, as these factors affect conditions of oxidation, reduction, temperature, and agitation of the water.

Deposits over the deep parts of almost every lake contain a high content of matter of organic origin. Profound changes take place on lake sediments after their deposition. Organic matter is eliminated, content of carbonates increase or decrease, and there are other important changes. Much formation of combustible gas, thought to be methane, is present, and a paraffin wax is extracted, bacteria and other micro-organisms being responsible for these changes. A bibliography of published literature referred to in the paper is given. R. J. W.

783.* Laboratory and Field Observations of Effect of Acidizing Oil Reservoirs Composed of Sands. P. E. Fitzgerald, J. R. James, and Ray L. Austin. *Bull. Amer. Ass. Petrol. Geol.*, 1941, **25**, 850–870.—The successful use of chemicals on oil and gas reservoirs composed of limestones has induced engineers and geologists to experiment with many wells producing from sands. Early results were not uniformly successful, probably owing to the same technique being applied as used for wells producing from limestones, but in some cases good increases resulted. During the past several years the authors have been collecting cores from various producing formations, most of which have been studied in the laboratory. Results, together with a compilation of well-treating data, are given in this paper. Three hundred cores were examined and studied, of which 80% showed an increase in permeability when acidized in the laboratory, the average increase being more than 300%. Average acid solubilities of the more than eighty different oil-producing sands was 8·5%. In the acidizing of sandstone formations the percentage of soluble material is by no means a criterion by which the possible success of a treatment may be predicted. In some instances better results have been obtained in sandstone formations containing low percentages of acid-soluble material than in those containing comparatively high amounts of soluble material. The usual tests on sandstone cores—that is, porosity, permeability, oil saturation, acid solubility, and chemical analysis—generally do not indicate with any degree of certainty results to be expected from acidizing. Additional tests were devised which gave more positive results, such as determination of permeability before and after acidizing the core in the laboratory, and determination of the compressive strength of the rock before and after

acidizing. The procedure of these tests is described. A chart showing production increases with quantity of acid required to saturate 1 ft. of sandstone and acid penetration in feet is given, from which is gleaned the gallons of acid per foot of "pay" required to saturate a sandstone of 20% porosity to a given radial distance. For example, 250 gals. of acid will saturate 1 ft. of formation a radial distance of 7·5 ft. If a 300% increase in permeability results from the presence of this acid in the pores, at least 50% increase in production can be expected. The occurrence of channelling due to formation irregularities will sometimes lead to even much greater production increases than indicated by the chart.

A summary of core studies by States and formations is given, and the authors hope to give all the core data in a future paper. R. J. W.

784.* Cross-section of Chester of Illinois Basin. P. L. Dana and E. H. Scobey. *Bull. Amer. Ass. Petrol. Geol.*, 1941 **25,** 871–882.—This paper deals with correlations of the formations of the Chester series in the Illinois basin, where, in the course of subsurface studies, certain critical lithologies have been observed, thus permitting the correlation of formations over wide areas. Over a zone 25 miles wide north and south, and out of some eighty sample logs, a group of seventeen logs were selected to construct east–west cross-sections of the basin, which are illustrated. The maximum distance between wells used was 15 miles, with an average of 11 miles. The results of the authors' studies and conclusions are described and a skeleton log is made, based on average thicknesses of formations, thus enabling the construction of a table to show relationship of formation names as used by subsurface workers in Illinois, Indiana, and Kentucky. A list of the wells and their locations is given. R. J. W.

785.* Geology of Freezeout Mountain—Bald Mountain Area, Carbon County, Wyoming. Milan D. Maravich. *Bull. Amer. Ass. Petrol. Geol.*, 1941, **25,** 883–897.—This paper forms a thesis submitted to the Department of Geology and the Committee on graduate study at the University of Wyoming, for the partial requirements of the degree of Master of Arts. It is a description of the geology of the south-eastern part of the Freezeout Hills, which are 15 miles north-west of the town of Medicine Bow, Carbon County, Wyoming, the mapped area covering 43 sq. miles of the north-eastern part of Carbon County. The geologic work was undertaken for the purpose of (1) obtaining an accurate geologic map; (2) describing and interpreting the structural geology; (3) measuring in detail the stratigraphic sections; and (4) investigating possible mineral deposits and ground-water resources of the area. The topography of the area is controlled by two north-west trending anticlines and an intervening syncline. The anticlines form ridges which increase in height and width south-westward, and the syncline forms a valley increasing in depth but decreasing in width to the south-west. The evidence available indicates that the mountain-making folding of the Laramic basin began in late Cretaceous time and continued intermittently to early Eocene time.
R. J. W.

786.* Hawkins Field, Wood County, Texas. H. J. McLellan. *Bull. Amer. Ass. Petrol. Geol.*, 1941, **25,** 898–899.—The Hawkins oil-field is located in South-eastern Wood County in the north-central part of the East Texas basin, and was discovered by use of surface geology and core-drilling.

A small surface structure was reported in 1930, but core-drilling in 1937 proved the structure to be much larger and more pronounced on the subsurface formations.

The discovery well, completed in December 1940 at a depth of 4963 ft., in the Woodbine, was plugged back to 4917 ft. and put on pump to produce 124 brl. of oil and about 290 brl. of salt water per day. The oil was black, with a gravity range of 15–18°. A second producing well completed in the same month had an initial production of 122 brls. per hour through a 1-in. tubing, choke-depth being 4648 ft. This oil was brownish black, with a gravity of 28·5°. The structure of the field appears to be an elliptical dome with its major axis bearing north 7° east. Wells drilled to date indicate that the gravity of the oil *decreases* with depth, being about 29° near the gas-oil contact and 15° at the water level. The field has a 20-acre spacing order with allowable based 50% on acreage and 50% on the well. R. J. W.

787.* Applied Sedimentology. Henry Carter Read. *Bull. Amer. Ass. Petrol. Geol.*, 1941, **25**, 899–901.—The author, following a review of a comprehensive report on the shoestring sand areas of Kansas and Oklahoma for the purpose of extending existing productive areas and developing new sand bodies with the least possible cost, has projected a method which he considers applicable to many sedimentary problems in general and to the shoestring areas in particular.

In this instance the lenticularity and sporadic occurrence of the sand bodies, accompanied by the absence of any surface reflection of subsurface conditions, precluded the use of ordinary exploration methods, the stimulus being shallow productive depths (2000–2500 ft.) combined with long life and low operating costs. His idea is that normal sedimentary units do not terminate abruptly, but "wedge" or thin out laterally, so that the problem resolves itself into a detailed study of the sediments involved.

He considers that if the cuttings from a number of previously drilled wells in several adjacent sand bodies are studied microscopically, and particular attention is paid to the characteristics of the material immediately overlying the sand body for a vertical distance of about 50 ft. and laterally beyond the limits of the actual sand occurrence, the data obtained can be used for control and location of other wells within the immediate area. Again, if the cuttings from the sand bodies are examined in a similar manner it will be noted that as the sand lens thins towards the edges, there is a proportionate loss of certain constituents, until the limit of the body is approached. At this point there are: (*a*) very few sand grains; (*b*) no sand grains; (*c*) a different type of grain; or (*d*) a transitional phase of the sand into the enclosing siltstone mass. By recording these data on a map it is evident that the percentage amount or kind of certain types can be interpolated between any two wells within the given sand body. The edge of the sand body can also be located by extrapolation.

The author considers that in addition to the ordinary microscopic examination of well-cuttings, the material should be examined under ultra-violet light, infra-red rays, and, if possible, be photographed by X-rays, in an attempt to ascertain diagnostic diffraction patterns of any of the constituent grains. Cuttings should also be subjected to the action of the common laboratory reagents, to determine whether certain characteristics can be chemically induced. As an accessory index geochemical analysis for gas content in the overlying siltstone can be used. Practical application of the proposals would necessitate the drilling of at least three wells in the area studied. The first two would be exploratory or "informative" wells, the third being located after studying cuttings from the first two as outlined. The formations passed through in the first two wells would be considered in a very different light than so much sandstone and shale, and the thin stringers of sand passed previously as a "stray" would be highly significant. The method would be more economical than drilling on the "hope-we-hit" basis. R. J. W.

788.* Potential Oil Area Disclosed in Southern South Dakota. *Petrol. Engr*, May 1941, **12** (8), 40.—A large anticline which may be of interest as regards oil has been found between the Big Bend of the Missouri river and the Bijou Hills in South-central South Dakota. Small gas-shows have been noted in water-wells on it. It is thought that the depth of sediments which may be petroliferous does not exceed 2500 ft.

About 8,000,000 acres are under lease in North and South Dakota for oil prospecting, but the area in question lies outside this region of leasing activity. G. D. H.

789.* Eastern Venezuela's Promising New Fields. *World Petrol.*, March 1941, **12** (3), 26.—In February Santa Barbara No. 1 came in at an estimated rate of 4000 brl./day of 29° oil from 87 ft. of sand. It lies 10 ml. from the Jusepin field, in an area which had been investigated by seismograph, torsion balance, gravimeter, and soil analysis. The well was stopped at 4320 ft. in shale, having encountered oil-sand at 4158 ft. Its bottom-hole pressure is 2000 lb./in.^{2}. The oil-sand resembles the upper sands at Jusepin.

Indications of another important field of high-gravity oil are shown by Santa Rosa No. 2, which came in at 6530 ft. with 2239 brl./day of 44·1° A.P.I. oil. It lies on one of a series of domes, extending about 30 ml. north-east from Santa Ana, four of which are already known to be oil-bearing. This is the Santa Ana–San Joaquin–El Roble–Santa Rosa area, which has nineteen producing wells, the deepest being

10,197 ft. San Joaquin has fourteen wells in a 20-ml. by 3-ml. area, whilst Santa Ana has two.

Oficina has 148 producing wells in an area 8 ml. by 5 ml. In the Leona–El Tigre region 30 ml. to the east, three producers have been completed. Anaco No. 1 is now at 7000 ft., and is expected to be a producer. Sites have been selected for four wells at Guario, where two wells are already giving more than 1000 brl./day, each of 40–41° oil. Two producers have been brought in at San Joaquin. 30 ml. south-west of Oficina the wildcat Panchita No. 1 is under way. A wildcat at Los Carito near Bocadeuracoa has been abandoned at 5756 ft. About 100 ml. due south of Caracas a showing of oil has been found in Mercedes No. 1. Rincon No. 1 is fishing at 9605 ft.

West of Santa Ana is the Las Oilas test. A third well has been completed at more than 2000 brl./day at El Roble. The well has two separate oil zones, the lower one at 9620–9650 ft. Apparently the area has three or more separate oil zones.

A map shows the fields, wells, pipe-lines, and refineries. G. D. H.

790.* Geology and Economic Significance of the Northern Great Plains Basin. J. A. Kornfeld, *World Petrol.*, March 1941, **12** (3), 36.—Recent drilling has indicated promising new objectives in a sedimentary section about 15,000 ft. thick in the Northern Great Plains Basin, which extends from Eastern Alberta to South Dakota.

In December 1940 the Princess field was discovered at Steveville, east of the Alberta foothills. The oil is in truncated, bevelled Palæozoic limestones, the structure of which beneath the thick Mesozoic mantle was outlined by the reflection seismograph. It is on the Sweetgrass Arch. The discovery well was drilled to the Devonian limestone at 4250 ft., and plugged back to the Madison at 3920 ft. It yields 520 brl. of 26·3° A.P.I. oil/day, with 12,750,000 cu. ft. of gas. Other tests are planned. Here and at Turner Valley the Madison limestone responds to acid treatment. Important reserves are believed to exist in the Jurassic, Mississippian, and Devonian.

At Del Bonita a well gives oil from the Upper Madison, and on the Blood Indian Reserve a well has had a fair showing of 36·5° oil in the Madison, but is drilling below 6440 ft. for the Devonian limestone. Palæozoic oil production is to be sought on the Baker–Glendive anticline, Montana, following geophysical work. Since 1936 two oil wells have been completed in the Big Snowy Group of the Mississippian at about 6750 ft. The Cedar Creek field gives shallow gas from the Judith River beds of the Upper Cretaceous.

The Bottineau gas-field of North Dakota was discovered in 1907. Its producing horizon is shallow. The production of gas at Lansford in glacial sands is probably migrant from the underlying Upper Cretaceous. A small gas-pool was developed in the La Moure county area at depths of 1150–1450 ft. in the Dakota sandstone. The Deslacs anticline had shallow gas. A gas-flow was found on the Nesson anticline at 750 ft., and a gas-showing was logged at 4300 ft.

In South Dakota a commercial well was drilled on the Barker structure in 1929, finding black oil at 1328 ft. On the east flank of the Black Hills uplift is the Elm Springs structure, on which the Lakota sand series showed oil at 3178–3520 ft. A gas-show was found in the Minnelusa below 4282 ft. The Deadwood formation showed oil at 7820 ft. on the Camp Crook anticline. A belt of shallow gas production from the Dakota sandstone occurs in Central and North-central South Dakota. It is on a broad structural terrace on the south-east flank of the Lemmon syncline.

8,000,000 acres have been leased in North and South Dakota since late in 1939.

Extensive geophysical work has been done in Alberta, North Dakota, Montana, and Saskatchewan. In Alberta it has been found possible to outline the structure of the surface of the Palæozoic limestone at depths of several thousand feet. In the Blood Indian Reserve on the north end of the Sweetgrass Arch south-west of Lethbridge, southern closure has been shown.

The Black Hills uplift is an irregular dome-shaped anticline 125 ml. long and 60 ml. wide, with a pre-Cambrian core surrounded by Upper Cambrian to late Cretaceous beds. There are many subordinate flexures, some due to laccoliths. The Sioux Arch is a low, broad arch with a pre-Cambrian core and Ordovician beds on the flanks. Within the Williston Basin, north-east of the Black Hills, is the Baker–Glendive anticline, which stretches 115 ml., and apparently overlies a pre-Cambrian basement fault. There is a Cretaceous inlier within the Tertiary. Several domes on the anticline have given gas, and two deep tests have found Palæozoic oil production

The Lewis fault separates the Rockies from the disturbed belt on the west of the Alberta syncline. The Sweetgrass Arch is a broad fold, 200 ml. long and 40–70 ml. wide, which dies out northwards at Medicine Hat. Its highest point is the Kevin–Sunburst dome on which the Madison is productive. The arch is modified by terraces and faults, and has truncated Palæozoic beds in the north, where the Madison is cavernous. Post-Cretaceous beds occupy the central part of the Alberta syncline, which extends from the Lesser Slave Lake to the International boundary.

Throughout South Alberta and Montana Middle Mesozoic beds overlie the Middle Palæozoic. In Manitoba the Palæozoic dips gently south-west from the edge of the Canadian shield, whilst South-west Saskatchewan has a broad basin of Mesozoic and Tertiary.

The stratigraphy of the area is described in brief. Oil-shows have been found in the Cambrian, Devonian, Mississippian (the Madison has yielded much oil and gas at Turner Valley, Kevin-Sunburst, etc.), and in the Jurassic.

The article is illustrated by a number of maps, outcrop, structural, and lease, and by a correlation chart for the Palæozoic of Iowa, Wyoming, and South Dakota.

G. D. H.

791.* Hungary's Expanding Oil Industry. *World Petrol.*, March 1941, **12** (3), 52.—Recent discoveries and increased drilling have brought the Hungarian oil output from 100 brl. in 1936 to about 1,725,000 brl. last year. Now the production is at the rate of 2,000,000 brl./year, and should be sufficient for domestic needs. The main source of new production is in the south-west (formerly known as the Lispe field), from which a pipe-line is being constructed to Budapest. The newest field is at Lovaszi, with four wells aggregating 800–900 brl./day of 39° A.P.I. oil from 4950–5380 ft.

The Budafapuszta (Lispe) field averaged 5200brl./day of 41° A.P.I. oil from forty wells at 3960–4950 ft. Sixty wells have been drilled at Bukkszek, where there is a declining production of 40 brl./day.

In Jugoslavia, just across the border from Lovaszi and Budafapuszta, are the two small oil-fields of Selenico and Peklenico.

A map is appended.

G. D. H.

792.* Maljamar Area Lime Wells Have Long Flowing Lives. D. H. Stormont, *Oil Gas J.*, 15.5.41, **40** (1), 23.—Lime-pay producers in the Artesia–Maljamar area of South-east New Mexico are characterized by their long flowing life and responsiveness to acidization. The average initial yields were about 150 brl./day, and now, after 14 years, the wells have almost the same potentials as when completed.

The first Maljamar production was discovered in 1926 at 4140 ft. Two other lime-fields to the west—Jackson and Grayburg—were found in 1929 and 1936, respectively. Together with later drilling this established the existence of an eastward-plunging anticline, with which nearly all Eddy County's present production is associated. The fields mentioned are all on or near the crest. Cementation and porosity to a large extent control the size of the wells in the sandy lime-pays, and the actual producing level differs in the different fields. In drilling at Maljamar oil-shows were also met at 2400 ft., and some production was obtained.

Production and completion data are given for the earliest wells in the Maljamar–Jackson area, together with production curves for some wells and a lease.

G. D. H.

793.* Lower Ordovician Found in Laurel County, Kentucky. W. V. Howard. *Oil Gas J.*, 15.5.41, **40** (1), 34.—Wells drilled around the Lexington dome have encountered a well-rounded porous sand, identified as the St. Peter. Farther to the east it fades out and a shaly formation takes its place. Recently oil-shows have been found in the St. Peter in Springfield Township, Erie County, Pennsylvania. A well on the Sinking Creek dome, Laurel County, Kentucky, met the St. Peter at 2972 ft., with a small gas-show and oil-stains, but the sand was too compact to produce. Shows were also reported in the Glen Dean, Golconda or Cypress, the Corniferous at 1190 ft., and the Trenton limestone at 1775, 1810, and 1820 ft. Correlation with two tests to the north showed the St. Peter to be lensing rapidly southwards.

The Sinking Creek dome covers 20,000 acres. The sands appear to thicken on the flanks, and possibly an oil-field will be found there. Practically all the structures of any importance in Laurel and Clay Counties are under lease. G. D. H.

794.* Recent Increase in Drilling May Bring Year above 1940. W. V. Howard. *Oil Gas J.*, 22.5.41, **40** (2), 41.—Records for the first four months of this year are almost equal to those for last year, and recent increases in activity will probably bring 1941's completions above that of 1940. Ohio is 21% ahead of last year, due mainly to extensive search for gas. Indiana is also ahead of last year as a result of wildcatting and drilling up of the Griffin and New Harmony areas. Kentucky has begun a keen search for gas. Illinois is 5% behind last year, Louden having been drilled up and the Devonian play at Centralia and Salem having passed its peak. However, several Illinois fields have not yet reached their limits. Continued wildcatting in Michigan has met with unfavourable results. No field in Kansas is particularly active, and except for East Texas all the major sub-divisions of that State show declines in activity compared with last year. The same is true of the Louisiana Gulf Coast, but in North Louisiana the activity is at about the 1940 level. Mississippi is ahead of last year, and, due chiefly to the development of gas-fields, the same is true of Montana and Colorado. Wyoming and New Mexico show declines, probably connected with marketing conditions. California seems unlikely to show much greater activity unless the Inglewood and Dominguez deep zones develop into town-lot plays.

The numbers of completions are tabulated by States for the first four months of 1940 and 1941. G. D. H.

795.* Orderly Development Indicated for Louden Devonian Play. W. V. Howard. *Oil Gas J.*, 29.5.41, **40** (3), 16.—A well has been completed in the Devonian at Louden, giving 681 brl. of oil in 8 hrs. through a ¼-in. choke. The Devonian discovery at Centralia led to a rise in production from 200,000 brl./month to a peak of 2,953,650 brl./month, and a subsequent decline in six months to 350,000. 318 Devonian wells were completed with an initial average of 1304 brl./day. It appears as though the ultimate Devonian production will be 13,000,000 brl., or 40,880 brl./well.

At Salem 542 wells were brought in in the Devonian, the average initial production being 1655 brl. The ultimate Devonian production here is expected to be 36,000,000 brl., or 66,420 brl./well.

Based on the Devonian history of Salem and Centralia, and the orderly development and production of Louden, it is expected that the Devonian will yield 4500 brl. of oil/acre. The productive area will probably be less than that of the Cypress, Paint Creek, and Benoist sands.

Devonian production has also been obtained at Bartelso, Irvington, Sandoval, Tonti, Sorento, and Decatur. The old Martinsville field gave Devonian oil. Dry Devonian holes have been drilled at Carlyle, Fairman, and Patoka.

Completion and production data are tabulated for the Devonian at Centralia and Salem. G. D. H.

796.* Nueces County Distillate Sands Carry Oil on Flank of Structure. N. Williams. *Oil Gas J.*, 12.6.41, **40** (5), 24.—Oil production has been developed down dip in the distillate sands of the Stratton field on the Lower Gulf Coast. Similarly, drilling on the east flank of the Agua Dulce field has shown oil down dip, although the work is too scattered to correlate the oil-sands with the crestal distillate sands. Both structures are on a north-east–south-west elongated anticline, some 12–14 ml. long and 2–2½ ml. wide in the distillate zone. They are separated by a narrow saddle. Recycling is carried out in certain sands in both fields.

The Stratton oil was discovered in June 1940, and forty-three oil-wells have now been drilled, twenty-four to the Bertram sand at about 6300 ft., two to the upper Sellers sand about 40 ft. below, three to the lower Sellers sand 60 ft. deeper, and fourteen to the Wardner sand a further 100 ft. below. The northern closure of the area is due to lensing of the sands in that direction, and on the east or down-dip side edge water has been located in some of the sands. There is speculation as to whether the productive area will swing round the south end of the distillate area or continue

southwards, for there is evidence of either another structure or of a southern continuation of the Agua Dulce–Stratton structure.

The Wardner and the Bertram are the main oil-producing horizons and the main recycling sands of the gas-distillate production. In addition to the sands mentioned, there are others which carry only gas and distillate. These are at 4800, 5000, and 6000 ft., and do not appear to have such extensive productive areas as the other sands. The Comstock is the only one of these sands which extends over the Agua Dulce area also. G. D. H.

797.* Brazilian Oil Campaign Given National Support. E. de Carvalho. *Oil Gas J.*, 12.6.41, **40** (5), 34.—Geological and geophysical surveys have been and are being carried out on the east coast of Brazil near São Salvador. The stratigraphical knowledge of this region is very scanty.

In the Lobato area a second well has been completed with a yield of 8 brl./day from 1300 ft. Structurally the field is an intricate arrangement of normal fault-blocks of widely differing displacements. In Alagoas a great thickness of sediments has been disclosed, and a fold with several domes and other structures favourable for oil accumulation have been indicated. There are also unconformable conditions.

The oil province of Brazil embraces several basins formed along the coastal belt of sedimentary rocks. The area is largely obscured by Pliocene beds (Barreiras formation). North of Alagoas Eocene beds underlie the Pliocene, whilst to the south Cretaceous rocks predominate. The coastal belt is only about 20 ml. wide, with pre-Cambrian rocks to the west. G. D. H.

798.* Well Logs and Field Data of Active Oil and Gas Areas—West Virginia. *Oil Gas J.*, 12.6.41, **40** (5), 54.—West Virginia is a part of the Appalachian geosyncline where the early development was best in the Mississippian, for the Devonian is rather shaly. On the margin of the basin in Ohio, Indiana, and Kentucky there was production from older beds, but for a long time they were deemed to be too deep in the centre of the basin for successful prospecting. At present in West Virginia there is shallow production down to the Berea (base of the Mississippian) with seventeen known sands, any of which may produce small quantities of oil or gas. In 1934 deep Oriskany production was found in West Virginia in the Elk district. In 1936 the Onondaga or Huntersville chert yielded gas, also in Kanawha County. These fields lie on the Chestnut Ridge, which seems to have the best petroliferous possibilities in West Virginia. Below the Oriskany the Clinton has given gas in the Kanawha district, and may prove important, although the Oriskany is generally considered to be the lowest important formation in West Virginia at present. The State is virtually untested below this level.

A map, stratigraphical column, and several well sections are included. G. D. H.

799.* Record of 1941 Completions Shows Drilling Trend. W. V. Howard. *Oil Gas J.*, 19.6.41, **40** (6), 17.—During the first five months of 1941, 7951 oil wells, 1030 gas wells, and 2554 dry holes were completed in U.S.A. Tables show the completions by States and districts, with the numbers and percentages of wells in each category, and the distribution of wells according to depth for the first five months of 1941. Deep wells predominate in West Texas, along the Gulf Coast, in California, and Wyoming, and in coastal Louisiana 287 of the wells were deeper than 10,000 ft. Wells 2500–5000 ft. deep predominate in Ohio, Indiana, Illinois, Kansas, Oklahoma, North, East and South Texas, New Mexico, Arkansas, and Montana. The average depths in the more active areas are more than 10% above the 1940 averages, but 897 wells were less than 1000 ft. deep, and 4365 wells 1000–2500 ft. deep. G. D. H.

800.* Leasing in Oklahoma Panhandle may Revive Drilling Campaign. R. Ingram. *Oil Gas J.*, 19.6.41, **40** (6), 18.—One of the many U.S.A. areas being closely examined for oil possibilities is the Oklahoma Panhandle, especially the extreme western edge, which probably lies on the westernmost flank of the Anadarko basin. Little is known of sub-surface conditions. Possible oil-bearing strata lie 4000 ft. deep, calling for geophysical work coupled with the scanty surface evidence and data from a few scattered wells.

About 1927 there was activity in the Panhandle, and by the beginning of February 1927 the Seminole production was more than 200,000 brl./day. Several tests on the Boise City dome, one of the few areas with useful outcrops, failed to give important production. The Pennsylvanian oil obtained at 4095 ft. was Oklahoma's deepest then.

It is believed that wrinkles with oil and gas possibilities in the Upper Pennsylvanian and Lower Permian will be found paralleling the Rockies, but these traps are not easy to find. During the last two years there has been extensive leasing, generally along north-west to south-east trends on the tip of the Anadarko basin, the eastern flanks of which have been highly productive at Oklahoma City, and on the south oil has been obtained at Cement and Chickasha.

Two maps are appended. G. D. H.

801.* Development of New Fields Boosts Illinois Production. H. F. Simons. *Oil Gas J.*, 26.6.41, **40** (7), 26.—After a period of stable or slightly falling production, Illinois has shown a rise since mid-May, and the rise may continue. The main field, Salem, has declined 22,000 brl./day since the beginning of the year, due to reduced output from the Devonian and upper zones, and failure to get large Trenton production. Centralia and Louden have declined 3000 and 5000 brl./day, respectively.

Continued wildcatting and the rapid development of extensions and discoveries have more than offset the declines mentioned. The chief discoveries are the Benton field, yielding Tar Springs production, and the proof that the Louden Devonian is productive.

It is believed that development can continue at the present rate for three to five years before exhausting possibilities to the extent that wide-scale prospecting will become uneconomic.

This year's discoveries are listed, and curves show the production, completions, dry and oil producing, and wildcatting results. G. D. H.

802.* Well Logs and Field Data of Active Oil Areas—North Texas. *Oil Gas J.*, 26.6.41, **40** (7), 50.—Development in North Texas (Wichita, Archer, Clay, and Montague counties, etc.) began more than twenty years ago with Burkburnett, Electra, and other shallow pools, and was largely limited to the Cisco (Upper Penn.). Production spread eastward without outstanding finds, and development was retarded by poor transport facilities. In 1933 commercial production was found in the Gunsight lime near Archer City, and in a Canyon lime of the Johnson pool. In 1934 Bend lime production was opened up in the Anarene pool and a small show was discovered in the Ellenburger east of Vernon. The K.M.A. field was the site of deep sand (Strawn) development in 1937, and this raised its output from 100,000 brl. in 1936 to 4,800,000 brl. in 1938. The sand was found to cover 70,000 acres. The Hull-Silk field came in in 1938 with two Strawn pays and one in the Bend lime. The rich Walnut Bend pool was opened in the Bend. Thirty-one discoveries were recorded in 1939, many being deeper sands in known pools; in 1940 there were thirty-two finds. Ellenburger production was found at K.M.A., and Mississippi lime production in Young County, whilst Hull-Silk now has ten distinct sands.

The major structural features are the Bend Arch and folds associated with the Wichita Mountains.

A map, stratigraphical column, and series of well logs are included. G. D. H.

803.* Benton is Best Field Found in Illinois this Year. H. F. Simons. *Oil Gas J.*, 3.7.41, **40** (8), 14.—The Benton pool, in the heart of Franklin County, gives more than 25,000 brl./day, and is the best field discovered in Illinois this year. It represents the first large sand production discovered in the southern part of the basin. The structure was delineated from data contained in mines and mine-prospecting bore-holes, and the area was later seismographed.

The first oil in Franklin County came from the St. Louis lime of the one-well Whittington pool, and late last summer a good McClosky lime-pay was discovered in the Thompsonville pool. The Benton field obtains oil from the Tar Springs sand, and has more than 100 producing wells. The Tar Springs sand has been found productive elsewhere in Illinois, although not so prolifically. Recently a new Tar

Springs pool was discovered near Sailor Springs in Clay County. The producing area at Benton is estimated to be about 1700 acres. The sand averages 34 ft. in thickness and has a break in some places. Wells have initial outputs of 50–912 brl./day and averaging 327 brl., and most have to be pumped. Practically all the wells produce some water, even those high on the structure. G. D. H.

804.* World Crude Output Rises in Face of War Crisis. J. L. Logan. *Oil Wkly*, 12.5.41, **101** (10), 39.—During 1940 2,150,356,000 brl. of crude were produced, 3·5% more than in 1939. The rise was due to an increase of 7% in the U.S.A. output, for the total production of the rest of the world fell. About 110,000,000 brl. of petroleum substitutes were made. Increases in production took place in U.S.A., Russia, Iran, Colombia, Trinidad, Argentina, Canada, and Burmah. Statistics are given of oil production for each country by years. G. D. H.

805.* Argentina's Oil Position Improved during 1940. *Oil Wkly*, 12.5.41, **101** (10), 45.—In 1940 Argentina's oil production was 20,642,298 brl., as compared with 18,642,755 brl. in 1939. Several pipe-lines were constructed, and two refineries were nearing completion.

Near Comodoro Rivadavia a field was found south of the Tordillo area, in the Pampa sandstone at 1700–1750 m., and 8 km. west of Plaza Huincul a gas reserve with some high-gravity oil was located in the Loma Negra district at 1000–1100 m. Several good wells were brought in in established fields. The main activity was in the Comodora Rivadavia area.

Tables give the production and well data, and a map shows the sites of oil-fields, refineries, and pipe-lines. G. D. H.

806.* Canada's Oil Industry Geared for War. C. J. Penn. *Oil Wkly*, 12.5.41, **101** (10), 50.—In 1940 Canada's oil output exceeded that of previous years. 130 ml. east of Calgary the Princess field was discovered, giving 26·3° A.P.I. oil from a depth of 3220 ft. at the rate of 520 brl./day with 12,750,000 cu. ft. of gas. Thirty-six wells were completed at Turner Valley during 1940.

Extensive exploration campaigns for gas are being planned for southern Ontario, where there has been a shortage of gas.

Political aspects of Canada's oil industry are discussed, together with Government regulations.

Tables give data about drilling at various points in 1940. G. D. H.

807.* Japanese Boost Mexican Drilling in 1940. *Oil Wkly*, 12.5.41, **101** (10), 64.—Sixteen oil wells and three gas wells were completed in Mexico in 1940. There were twenty-five failures. A Japanese company drilled thirteen wells in the Northern district and two on the Isthmus of Tehuantepec. Out of 6572 completions to the end of 1940, 2616 have yielded oil or gas.

During 1940, 44,000,000 brl. of oil were produced, Poza Rica giving about 28,000,000 brl. 20,555,000 brl. of oil were exported, the bulk of it to U.S.A.

Tables summarize the production and well data for 1939 and 1940 by districts. G. D. H.

808.* New Eastern Fields Improve Venezuela Possibilities. J. V. Hightower. *Oil Wkly*, 12.5.41, **101** (10), 87.—In 1940 Venezuela produced 186,134,390 brl. of oil, against 205,432,654 brl. in 1939, the reduction being due to the war. Eastern Venezuela gave 48,700,000 brl., as compared with 35,060,000 brl. in 1939. This rise was the result of the discovery of new fields, the opening of the Mene Grande pipe-line, and the reduced demand for the heavy Maracaibo oils. The El Roble field was expanded. It yields oil from the lower Oficina formation of the Oligocene at depths of 8000–10,000 ft. North-east of the San Joaquin field oil production was obtained on the Guario dome. 10 ml. south-west of San Joaquin Santa Ana found oil in 1939, whilst 2 ml. to the east Rincon Largo 1 was giving 385 brl./day from 8775–8790 ft.

In the Leona field oil is found at 6486–6504 ft., 6312–6321 ft., and 6293–6305 ft.,

but this field is closed in. This year oil has been found at Santa Rosa and Santa Barbara.

22 ml. west of Oficina a little oil was found in Socorro 1, although later wells were dry. Information is given about other dry wells.

There have been pipe-line and refinery extensions during 1940.

A map shows oil-fields, pipe-lines, and refineries, and a table provides data on production in 1939 and 1940 as well as data for 1940 by fields. G. D. H.

809.* Colombian Wildcatting to Continue over Wide Area. J. V. Hightower. *Oil Wkly*, 12.5.41, **101** (10), 104.—In 1940 the Colombian production was 25,556,000 brl., against 23,848,000 brl. in 1939, the bulk being exported. There were no outstanding developments from wildcatting in 1940. The Restrepo concession of the upper Magdalena valley was abandoned. More than three-quarters of the 1940 production came from Infantas and La Cira, whilst Petrolea provided almost all the remainder. Results on the Barco concession were not very encouraging, but late in 1940 a new producing area was found by the successful completion of a small producer, Tres Bocas 1, which came in at 3000 ft. after plugging back 5000 ft.

In the Magdalena valley there was considerable activity following the discovery of a sand at 2500 ft. on the Monte Oscuro anticline, east of Nare, but several wells have had to be abandoned. Narino 3 found a small but unimportant amount of oil, and Las Monas 1 gave a few barrels of oil/day. These latter wells are on the Restrepo concession.

During 1940 new concessions were granted in the Magdalena valley and the Llanos region.

A map shows the pipe-lines, fields, and concessions. G. D. H.

810.* Development Programme in Prospect for Ecuador. *Oil Wkly*, 12.5.41, **101** (10), 117.—Concessions cover the entire Pacific coastline of Ecuador and much of the interior, especially that part east of the Andes. Only in the Santa Elena area has production been obtained, but elsewhere there has been geological and geophysical work, with drilling apparently about to be undertaken at several points. The various holders of the concessions are enumerated, with brief details of the area, work done, etc. G. D. H.

811.* Ecuador Shows Steady Upward Trend in Crude Output. *Oil Wkly*, 12.5.41, **101** (10), 120.—Ecuador's production rose from 1925 to 1931, but fell in 1932. The upward trend was resumed in 1933. During 1939 2,312,520 brl. of oil were produced, making a total of 21,752,351 brl. in fifteen years.

Refining began in 1930, and in 1939 420,711 brl. of refined products were made. The exports in 1939 were to France, Uruguay, England, Japan, Brazil, Germany, and Argentina. A table gives the outputs of the various companies by years, and a map shows the fields, refineries, and concessions. G. D. H.

812.* Eight Drilling Rigs at Work in Brazil. *Oil Wkly*, 12.5.41, **101** (10), 132.—More than twenty years ago petroleum studies were begun in Brazil, but the first producing field, Lobato, was only discovered early in 1939. At present eight rigs are in operation in the coastal region, four being at Lobato. Three tests are reported to have found two distinct producing levels of possible economic value, which are now being tested.

A map shows the positions of the present and past drilling operations. G. D. H.

813.* Ancon Oil Field in Ecuador Continues Active. *Oil Wkly*, 12.5.41, **101** (10), 144.—The Ancon field, the only important oil field in Ecuador, was discovered in 1923. Its two producing formations have proved quite prolific, probably due to the considerable thickness of sand. It is a flat-topped anticlinal structure involving Oligocene and Miocene beds, with considerable surface fracturing and faulting, and it covers 12,000 acres. The shallow Socorro sand lies at 200 to 1300 ft., giving 17° Bé oil, whilst the more important Atlanta sandstone yields 40° Bé oil at depths of 1200 to 3600 ft. from a formation which is 2500 ft. thick in places. The Socorro oil is

under water drive, but gas is the driving force in the Atlanta. Initial outputs up to 2000 brl./day, with a slow decline, are features of the latter horizon. The wells in the former average only 30–40 brl./day initially.

Drilling is hard, and producing wells have to be cleared of paraffin every nine months.

A table gives the age, area, production during 1939 and 1940, and the total production to the end of 1940, together with data about wells, for the various producing areas of Ecuador. G. D. H.

814.* West Central Wyoming Outlook Brightened by Deeper Pays. F. B. Taylor. *Oil Wkly*, 16.6.41, **102** (2), 24.—Prolific high-gravity oil production has been developed in recent years on several structures in the Lost Soldier district of Wyoming. Gas had previously been found at a number of points, some of which yielded oil also, but the characteristics of the oil led to its not being in demand. The deeper crude has proved more desirable, and thus in the past two years efforts have been made to develop this deeper zone. Prior to 1936 eight of the structures tested gave only gas, and that was chiefly from the Frontier, Dakota, Morrison, and Sundance. Lost Soldier, however, gave 19,000,000 brl. of light oil from the Frontier, Sundance, and Dakota. The Embar and Tensleep had been exploited only in the Dallas, Derby, and Lander fields, structures which were near the mountains, with the younger horizons deeply eroded and the oil heavy. In 1936 a 5870-ft. well to the Tensleep in the Wertz gas-field came in at 2000 brl./day, starting the search for the deeper production. The oil reserve at Wertz is estimated at 30,000–40,000 brl./acre.

All the fields of this region lie around the edge of a main sedimentary basin and relatively near the surface outcrops of the basement complex. Tertiary beds rest unconformably on older beds. The various oil- and gas-fields, Alkali Butte, Big Sand Draw, Bunker Hill, Dallas, Derby, Lander, Ferris, Middle Ferris, West Ferris, Lost Soldier, Muskrat, Mahoney, and Wertz, are all on domes. The structure and producing horizons of each of these fields are briefly described.

Maps, correlation-penetration charts, and tabulated field data are included. G. D. H.

815.* Wells Deeper and Footage Off Less than Completions. *Oil Wkly*, 14.7.41, **102** (6), 97.—In the first six months of this year there were 3·9% fewer completions in U.S.A. than in the corresponding period of last year. 14,425 wells were drilled with a total footage of 43,246,211 ft. The average depth was 3061 ft. for new wells. 355 wells were deepened by an average of 499 ft. Most deep drilling took place in Southern Louisiana, where the average depth was 7724 ft., whilst the Texas Gulf Coast and California, with 6512 ft. and 5708 ft., respectively, were second and third as regards average depth of drilling.

Tables show the numbers of wells completed, footage and average depth by years from 1925, and by districts for the first halves of 1940 and 1941. G. D. H.

816.* War takes a Hand in Foreign Drilling. J. V. Hightower. *Oil Wkly*, 14.7.41, **102** (6), 104.—In Canada the Princess field, 130 ml. east of Calgary, was opened in January with a well giving 520 brl. of oil/day from a depth of 3260 ft. The Athabasca tar sands are now being exploited commercially by a plant which processes 400 tons of oil-sand per day.

During the first four months of 1941 Mexico's output was 11,800,000 brl., compared with 13,000,000 brl. in the same period of last year. Lack of outlet has caused the fall. Export recovery has given a rise in Venezuela's production. Several new fields have been discovered in the east—Santa Rosa, Santa Barbara, Las Ollas. Details are given concerning some of the wildcats. Drilling activity has revived in western Venezuela.

The bulk of the Colombian oil is still derived from the De Mares concession. Argentina's oil output rose 10% during the first three months of 1941 by increasing the withdrawals from old fields. Several wildcats seem to have failed to give encouraging results, and the amount of drilling in the new field 20 ml. south of El Tordillo Oriental is not disclosed.

The combined output of Bahrein, Iran, Iraq, and Saudi Arabia in the first four months of 1941 was only 83% of that for the corresponding period of last year, the fall being due largely to the 60% decline in Iraq's output. G. D. H.

817.* United States Sustains High Discovery Rate. *Oil Wkly*, 14.7.41, **102** (6), 116.—During the first six months of 1941 about 130 fields were discovered in the U.S.A., and old fields yielded 100 new pay horizons. North Texas provided fourteen new oil areas and thirteen new oil levels, mainly in deep lime and sand zones. The Mississippian lime showed further promise of being a good source of high-gravity oil. Ellenberger oil was found at Electra, and also in Pecos County, West Texas, in which region there were major extensions at Foster, Goldsmith, Sand Hills, and Abell. In East Texas the Hawkins field has been virtually defined, and oil has been found on the west flank of the Willow Springs deep gas-distillate field. There has been extensive leasing in the Anadarko Basin in the Panhandle, with the object of testing below the Permian.

On the Texas Gulf coast three Wilcox fields, four Cockfield-Yegua, four Frio, and one Miocene field have been discovered. In the Agua Dulce–Stratton area a series of new sands was opened up in the Frio at 6000–7200 ft. A revival of shallow activity has taken place in the San Antonio region with a number of completions in the Cretaceous.

Benton, giving oil from the Tar Springs at about 2160 ft., is outstanding amongst the eighteen Illinois discoveries. Four oil-pools and two gas areas were opened in Indiana, but wildcatting was at a very low level in Michigan, with only a few minor discoveries. The majority of finds in Oklahoma have been small, but Guthrie, Tecumseh Lake, Apache, and Deep Bromide (Velma) may become sizeable fields. There were no outstanding discoveries in Kansas. Activity centred on Falls City and Shubert in Nebraska. The flank of the Cambridge Arch was tested in Dawson County. Twelve new fields were located in Southern Louisiana, and in the north distillate production was found in the Smackover lime on the north-east flank of the Lisbon field. The Sentous deep zone appears to have been the most important new development in California. G. D. H.

Aerial Survey.

818.* Mapping from Aerial Surveys. A. T. Britton. *J. Instn Engrs (Australia)*, May 1941, **13**, (5), 121–126.—This report is a general survey of mapping from aerial surveys, dealing with cost, instruments, planimetry, determination of heights, ground control, and organization. While good flying is one of the first essentials, and by no means easy to achieve, the paper points out what plotting really involves, and shows that it is of greater importance than the flying. B. M. H. T.

Drilling.

819.* Characteristics and Application of an Oil-base Mud. H. W. Hindry. *Petrol. Tech.*, May 1941, A.I.M.M.E. Tech. Pub. No. 1322, 1–6.—Oil-base muds of suitable constitution have excellent plastering properties which reduce damage to reservoir horizons such as may be caused by infiltrating water, give a thin filter cake, and hence greater clearances, remove trouble from heaving shales, give an easily removable mud sheath, and provide cores not contaminated by water. These muds are made of stove oil, oyster shells, limestone (bulk passing 200 mesh), or barite for weighting, lampblack to give gel strength, and blown asphalt to give plastering properties. A series of curves shows how weight, viscosity, settling and filter loss are affected by varying the proportions of these materials. Filter loss is markedly affected by the proportion of blown asphalt, whilst the amount of lampblack profoundly affects the viscosity. Muds weighing up to 95 lb./cu. ft. have been prepared. The amount of lampblack ranges up to 11%, asphalt to 18%, barite to 54%, and oyster shells to 44%. Facilities for handling oil-base mud are similar to those for ordinary muds, but there should be storage facilities for the various constituents of oil-base mud, rubber fittings for pumps and drill-pipe protectors should be oil-resisting, and of course precautions must be taken against fire. Contamination with much water should be avoided, as well as exposure to high

temperatures for several hours. Gas-cutting does not occur readily. Electric logs can be made by using special electrodes which make contact with the well walls. Drilling rates are slightly slower than with water-base muds, and costs are rather higher.
G. D. H.

820.* **Power-Drilling Rigs.** N. A. D'Arcy, Jr. *Petrol. World*, May 1941, **37** (5), 43.—After a brief historical review of the development of power-rigs, their advantages are discussed. The greatest advantage achieved is that a power-rig will drill a hole with approximately one-tenth the fuel required on a similar job by a conventional steam equipment. Power-rigs are compact and simple to move. A complete power-drilling installation, including pipe-racks, mud-sumps, derrick, and internal-combustion engines, can be set up in approximately half the space normally required for a steam-drilling rig, including the boilers and boiler-feed water-tanks. This compact rig often saves thousands of dollars on hillside locations, and sometimes makes possible town-lot installations that would not be possible with steam-rigs.

Moving a large power-rig in from 12 to 18 hrs. from completion to spudding in is common practice, and this moving time can be made as easily on locations several hundred miles apart as on those a few hundred yards apart. Tables give comparative studies of power- and steam-rigs.

The hydraulic clutch is similar to the fluid-drive in automobiles. This clutch is about 95% efficient, and transmits to the driven shaft a torque equal to that developed in the engine. Provision is made to cool the oil when the clutch is slipped, and it is reported that the fluid-clutch has satisfactorily transmitted the full torque of the engine to stalled slush-pumps for several hours at a time.

The fluid-clutch has a slip at slow speeds when placed on a hoisting drive. This produces a lag in acceleration on the drum and decreases the time required to hoist a stand of pipe. On slush-pump drives the speed is more nearly constant, and this device should be very advantageous. It will not only allow the operator to hold pressure on a stalled pump, but it should also absorb much of the impact developed in the pump.

The torque converter is another hydraulic drive, but it is very different from the hydraulic clutch. It is in reality a hydraulic pump which develops high kinetic energy in the fluid, that in turn is transmitted to the driven member. The torque converter develops from two to five times the torque developed by the engine when the driven shaft is stalled. This results in very high line-pulls when starting each hoisting cycle and a rapid acceleration up to maximum hoisting speed. The torque converter is only about 85% efficient, but it is claimed that the overall efficiency of hoisting is greater with a torque-converter installation than without.

An experimental converter with an internal hydraulic reversing mechanism is briefly discussed.

Field installations show that the torque converter has a decided possibility when installed in the hoisting end of a power-rig. It is doubtful if torque converters should be used on pump-drives or rotary drives. The extreme torque developed on a stuck drill-pipe could easily produce "twist offs," and the excessive load imparted to slush-pump piston-rods and cylinders when the pump is installed could blow up the fluid end.

Methods of compounding engines are discussed.
A. H. N.

821.* **Field Care of Rotary Tool-Joints.** R. I. Gardner. *Petrol. World*, June 1941, **38** (6), 54.—New tool-joints should be thoroughly cleaned and inspected at the rig prior to use. There are good reasons for doing this. If a tool-joint galls after being placed in service it is almost impossible to definitely locate the cause of the galling. Therefore it is important to know that the joints are in good condition when first put together.

New joints should not be re-doped until they are on the derrick floor. This extra precaution is necessary because new joints should be absolutely clean when first put together. Before re-doping, all traces of the original lubricant, wood splinters, and grit should be removed.

When re-doping, it is good practice to use the lubricant recommended by the tool-joint manufacturer. However, most of the available tool-joint lubricants, consisting of a heavy oil mixed with finely ground lead or zinc, are satisfactory. The lubricant

should be applied in a light, even layer on all mating surfaces. A shoe-brush has been found very effective in applying lubricant to the box-end threads, whilst a long-bristled paint-brush is satisfactory for the pins.

It is of paramount importance not to use a spinning rope while the joints are new. New joints should be put together with hand-tongs as far as possible. At this point the regular power-tongs should be used, but not in the usual manner. The joint should be tightened and loosened two or three times, beginning with moderate torque and increasing each time. Before the final tightening the joint should be unscrewed and re-doped. By following this procedure, numerous strings of drill-pipe have been put in service without any joint trouble.

Cleanliness is of prime importance in the life of tool-joint threads. Although it is not practicable to clean the joints each time they are made-up, any effort spent in making sure that the joints are clean will yield dividends in better tool-joint service. If the threads are thoroughly cleaned just prior to arriving on the derrick floor, it is a simple matter to keep them free from foreign matter thereafter.

Damage to tool-joint threads while the pipe is lying on the derrick rack probably accounts for the greater part of tool-joint thread trouble. In general appearance a joint of drill-pipe looks very sturdy and hard to damage. That is not the case, however, for it takes only a light blow on the end to destroy entirely its usefulness. The blow resulting from a bit or similar object striking the end of a tool-joint is often sufficient to damage it. That such light blows can cause serious damage is not generally recognized because the threads are usually covered with a thick layer of lubricant, which hides the damage. After inspecting numerous tool-joint failures it has been found that most of them resulted from undetected damage to the threads or shoulders.

A detailed procedure for periodic inspection is given, and this includes inspection of (1) straightness of pipe; (2) galling and damage to threads and tool-joint shoulders; (3) outside wear of tool-joints; (4) field repairs; and (5) condition of pipe.

A. H. N.

822.* Combination Rotary and Cable-Tool Drilling in Michigan. H. G. Hunt. *Oil Gas J.*, 24.4.41, **39** (50), 65.—*Paper Presented before American Petroleum Institute.*—The State of Michigan has made more progressive strides in the use of rotary than any other State in the East of the U.S.A. with the exception of Illinois. Michigan is more similar to the other eastern States than Illinois, because of more lime formations occurring in it than in the latter State. The use of combination drilling in Michigan came about through trial and error due to the thickness of glacial beds, pencil caves in the central part of the State, and difficulties encountered in cable-tool drilling and resultant under-reaming.

The Michigan law requires a string of pipe to be set through the Marshall brine sand. As a result of the expense and difficulties in connection with cable-tool drilling, rotary operations started in Michigan in 1928, and increased gradually as pioneering work was done. The combination outfits came into use in 1934. Experience is at present insufficient to determine the difference in pipe-saving through the use of rotary, but the saving is appreciable. There is also a time saving of 37% in favour of the rotary. It is believed that the rotary has justified its retention not only in light-weight drilling and slim-hole operations, but even in the heavy-duty rotary type of operations. However, it is not thought that the cable-tool rig will disappear, as it has advantages in the lower sections of a hole.

A. H. N.

823.* Building Up Shoulders on Worn Tool-Joints. Anon. *Oil Gas J.*, 15.5.41, **40** (1), 46.—The point of greatest wear on a tool-joint is at the lower end of the box. The shoulder between the tool-joint and pipe receives the full force of the cutting action of the mud-stream as it rises in the hole. This mud-stream carries the small particles of formation which have been cut by the bit, and the continuous bombardment of these particles will cause a rounding-off, or stream-lining, of the shoulder. Another factor contributing to the wear at this point is the contact with the walls of the hole as the pipe is lowered while making a trip or while drilling. The shoulder on the pin end escapes much of this wear, as the channel for the fluid stream is expanded instead of being contracted as it passes over the shoulder on the pin and the contact with the wall of the hole is less frequent and severe.

Removal of the metal body of the joint produces another danger zone at the threaded portion of the box. A substantial reduction in the thickness of the walls of the tool-joint at this point may produce a slight spreading which would permit shouldering of the two faces and produce a leaky and weakened joint.

Special equipment and technique of building up shoulders by welding are described and illustrated. A. H. N.

824.* **Obtaining Maximum Efficiency in Firing Oil-Country Boilers.** R. Reed. *Oil Gas J.*, 15.5.41, **40** (1), 51–52.—The standard type of oil-country boiler is a prolific generator of steam when given an opportunity to perform. Standard practice with these boilers is to provide a very large firebox made of steel. Water is on all sides of the firebox, where a tremendous radiant heat-absorption factor may be realized. Recent experiments seem to indicate that larger fireboxes add to the steaming rate of oil-country boilers.

Tremendous increments of available energy are being realized through superheating the steam. The higher the superheat within the limits of the machines being operated the more efficiently can they be made to operate. Some operators set up separately fired furnaces to superheat the steam. It is said that in this manner two boilers may be made to do the work of several.

Provision should be made to use all the exhaust steam possible to preheat the feed-water. Saturated steam at 250-lb. pressure has a total heat content of 1201·2 B.Th.U./lb. Of this heat content, 381 B.Th.U. are introduced before steaming begins. After steaming begins 819 B.Th.U. are introduced to cause the water to change its state from liquid to vapour at 250-lb. pressure. The 381 B.Th.U. are referred to as "specific" heat, the 819 B.Th.U. as "latent" heat. A good portion of the specific heat may be taken care of through the use of preheating devices. For instance, if water is preheated from 60° to 200° F., 140 B.Th.U. of the specific heat are put into the water before the burners take charge.

Where the gas is burned quickly and entirely consumed before it strikes heating surfaces, efficient operation may be obtained. Where the gas burns slowly and wanders around in the firebox until it comes in contact with the relatively cold metal surfaces, the burning gas is chilled below the kindling point of the gas and carbon monoxide is released in the firebox. This monoxide comes from the relatively cold zone into a zone above its kindling temperature and re-ignites. When this phenomenon occurs at a relatively high rate, "drumming" occurs. The so-called drumming is the sound made by the concussion produced as the gas re-ignites. While everyone understands that monoxide or incomplete combustion causes drumming, no one is prepared to say why a particular type or make of burner will drum in one case and will not drum in another. It may be said, however, that drumming is a characteristic of steel firebox boilers.

Burners are discussed. A. H. N.

825.* **Mud Flow in Drilling.** R. J. S. Pigott. *Oil Gas J.*, 22.5.41, **40** (2), 62. *Paper Presented before American Petroleum Institute.*—Tests made on 4-in. pipe, on capillary tubes, on ½- and 1-in. pipes and a modified McMichael absolute viscosimeter were used to demonstrate that the flow of mud can be predicted in the viscous region by utilizing the variable apparent viscosity in place of the usual constant viscosity for a liquid.

In the turbulent region of flow all plastic effects, and consequently variation of viscosity, disappear: then mud can be treated as a true liquid. Experiments show that in this region the viscosity of mud is surprisingly low. The two different formulæ which must be used for suspension of cuttings respectively in viscous and turbulent flow are discussed, together with modifications necessary for cuttings other than round particles.

The general conclusions are: (1) The pressure drops and the sustaining effect of any mud can be computed quite accurately, given the complete viscosity–velocity relations and density of the mud. (2) Attention should be given to balancing pressure drops as between drill-pipe and hole, whenever feasible, to keep the total pressure in the pumps down. (3) Velocity is useful for lifting, but is limited by the pump pressures required. Reasonably high density is valuable for lifting, but also opposes dropping cuttings. (4) Viscosity is generally objectionable; it raises pumping pressures; and

because in muds it is practically inversely proportional to velocity in the viscous region (mud pit), it is the most serious obstacle to dropping cuttings. Gelling to sustain cuttings when circulation is stopped is now easily obtained without high apparent viscosity in motion.

The paper is well illustrated by sixteen quantitative graphs and seven tables.

A. H. N.

826.* Deep Michigan Test Uses New Mud System and Treatment. H. F. Simons, *Oil Gas J.*, 29.5.41, **40** (3), 34.—Principal features of the mud system are the tanks for circulating, storing, and treating the mud, and a de-gasser. In addition, should it prove necessary, the mud can be passed through an oil-gas separator. The mud treatment which has allowed the operation to be successfully pursued incorporates a new compound which imparts a colloidal property to the drilling fluid in the presence of salt water. The drilling fluid at present being used was made from admixtures and salt water instead of the usual fresh water.

The problem of mud control on the Bateson well is not a simple one, as there are three complicating factors: high gas pressures, a large salt section and salt-water-bearing sands, and hydrogen sulphide gas. In addition, there are several sands which will allow a thick filter cake to be built up in case the filtration qualities of the mud are not properly maintained; also a washed-out section which requires that a reasonably high viscosity be maintained for the mud-stream to carry the cuttings out of the hole.

A detailed account is given of the problems met and the methods adopted for their solution, giving exact data and properties of muds used. The plant is similarly discussed and illustrated in detail.

A. H. N.

827.* Deep-Well Practices in Oklahoma City. H. F. Simons. *Oil Gas J.*, 19.6.41, **40** (6), 34.—Oklahoma City was not the first place in which a well was washed with tubing, at least one previous place in Oklahoma being recorded. However, it was in Oklahoma City that the practice reached prominence, and this is currently the most commonly used method of completing high-pressure wells. The method used was to core or drill the pay, run and cement the casing, and drill the plug with rotary. The tubing was then run to bottom and the mud displaced with clear water until the well kicked off and started to flow. Previous to the introduction of this way of doing it, completions had been attempted with cable tools, but trouble occurred with sticking.

Another method of completion was to set the pipe, drill in with heavy mud, and then string up a bailing line. After running the bailer a few times, the wells start to head, and as soon as the mud was blown out into the pits, the stream would be turned into the separators.

The first wholesale attempt to decrease the time required for drilling a well by proper mud treatment was at Oklahoma City. Contractors found by experimenting that a thin mud with other desirable qualities was sufficient for drilling most of the hole, and that the rate of penetration was increased. The mud was weighted at the proper time to prevent blow-outs.

Other practices are credited to the same place. The greatest contribution made by Oklahoma City has been in the science of pumping. Had the field not returned a profit it would have been a benefit to the petroleum industry because of the improved pumping practices developed. Practically every conceivable method for lifting oil has been tried in Oklahoma City and many pieces of equipment have been perfected there. While deeper wells have been pumped, it is the largest single application of deep pumping. Prior to its development, fields above 5000 ft. had been the testing ground for pumping equipment. The stepping up of the depth to 6500 ft. created so many additional problems that some then believed it would be impossible to pump the wells in Oklahoma City. The solutions of the various problems are briefly discussed.

A. H. N.

828.* West Lake Field Practices. N. Williams. *Oil Gas J.*, 26.6.41, **40** (7), 42–44.—Production at West Lake Verret previously has been found in sands ranging in depth from 7400 to 8900 ft. Eight wells had been completed in these sands; in addition, there is a gas well, completed in a shallower sand, which was drilled to supply fuel for field operations. The deep producer is one of seven tests that have been drilled to

greater depths in exploration of lower horizons, two of which were carried to depths below that of the deep producer.

Drilling and completion of the deep producer involved no major problems or difficulties other than the normal hazards of deep drilling. Only two minor fishing jobs marred the record of the well, which was drilled and completed in an overall time of only 52 days.

From an operating standpoint, conditions in the West Lake Verret field generally have been unusually favourable. Porous formations and cavities that have caused loss of returns have been encountered at shallow levels in several wells. Also in one of the deep tests (4 Jeanerette) a salt-water flow at 11,890 ft. necessitated quitting the hole at that depth and plugging back to one of the regular sands for completion; otherwise drilling has been more or less uneventful. So far no excessive gas pressures have been encountered, although every precaution is taken to guard against any eventualities. The operations are described in some detail. A. H. N.

829.* War May Affect Many Practices in the Petroleum Industry. H. F. Simons. *Oil Gas J.*, 3.7.41, **40** (8), 28–30.—At the present time there is little actual shortage of equipment in the drilling and producing departments, but there is considerable fear that a scarcity is in the offing. Key to the situation is the Priorities Board, which to date has not looked into the oil business sufficiently to get an idea of its requirements. The accompanying article does not predict a shortage of material, but points out some of the things that may be done to avert shortages and the methods being considered by oil-company and drilling organizations to keep operations going smoothly.

A reduction in the steel tonnage necessary for casing is being brought about by three methods: the elimination of surface and intermediate strings whenever possible, the use of second-hand casing and obsolescent sizes and types, and the wider use of small-diameter pipe. This latter has been an important move in the past several years, and each month sees more companies using 6¼-, 5½-, 5-, and 4½-in. pipe. With only a certain amount of steel available, a 50% reduction in the weight of casing used is an important saving. The reduction in casing size can be carried too far, however, and in the final analysis it is more important to see that the well is properly cased than it is to save the steel tonnage. In most cases the reduction can be made without harm to the well, but this is by no means a universal rule.

The most important threat to the producing branch is the withdrawal of nickel-alloy steels from all but defence industries. The oil industry has been one of the leaders in the use of special alloys, particularly nickel steels, and its acceptance and willingness to pay for better materials have been a contributing factor in building up the nation's normal production of these items.

Most important uses of such steel have been in the sucker rods used in deep wells, special types of rod-pumps, polish rods, valves, etc. In deep wells and in wells where corrosion or embrittlement is a problem the improved rods and metal-to-metal pumps have been important factors in reducing operating costs. Rod breakage has been almost entirely eliminated in deep holes, due to the development of the nickel-steel rod over a period of years. The number of times it has been necessary to pull the rods and tubing in order to repair the pump has been substantially reduced through the use of the advanced types of pumps.

In shallow wells in which corrosion is not present the problem will not be severe, but will add slightly to the production costs. In the deep wells, or in those handling sour crude oil or large quantities of salt water, it will be an important problem, and will greatly increase the number of pulling jobs. The number of machines and crews engaged in this work will probably increase considerably over the next two years.
A. H. N.

830.* Skidding Rigs on Savannahs of Eastern Venezuela. F. E. Hatfield. *Oil Gas J.*, 3.7.41, **40** (8), 33.—The flat, treeless savannah was ideal for skidding of derricks. Although the well-depths of from 5500 to 6000 ft. required quite heavy equipment; by close co-operation of both drilling and transportation personnel a technique was evolved which permitted the rapid skidding of rigs and derricks for considerable distances and made possible the rigging up of equipment within satisfactory time limits.

The first step was to equip the derrick for skidding. There were 14 × 14-in. native

hardwood timbers called " vera " already on hand which proved ideal for derrick sills. This wood is harder than oak—so hard that to drill bolt-holes tool-steel drills had to be used. Its resistance to abrasion, however, permitted the employment of the rapid skidding method finally adopted, and following many skids, only a few sills have been replaced. After some initial experiment using 4-in. pipe rollers and 3 × 12-in. skid boards it was discovered that, because of the flat, grassy surface, very little more power was needed to move the derrick over the savannah without the use of rollers or board tracks; that the job could be accomplished much cheaper and quicker, with no damage to derrick or substructure.

The method is detailed and illustrated. A. H. N.

831.* Analysis of Mud Returns Locates Oil and Gas Zones. E. Sterrett. *Oil Wkly*, 31.3.41, **101** (4), 49.—Mud-analysis logging finds particular application in areas where production is from lime, or where muds have high saline content. Where coring is difficult or hazardous, or where core recoveries are bad, mud-analysis logging furnishes a means of obtaining corroborating data on those formations carrying oil or gas.

In wildcat drilling in hard-rock formations, where drilling is relatively slow, the usual programme is to drill ahead for 3 ft. and then circulate mud until known returns appear from the bottom. Showings thus obtained determine the advisability of coring or going ahead with routine drilling, and prevent the unprofitable coring of shale or other non-productive formations.

Mud analysis for gas- and oil-showings is especially well fitted for determining productive formations, and for locating the gas-oil contact, when drilling in formations which have comparable penetration rates, and where no other change in drilling data is observable.

Various tests and methods of mud analysis are described. The gas detector using a hot filament is also described. An instrument is also available for use with gas detectors of the filament type, in which a known volume of drilling mud is trapped and subjected to a given increment of pressure. Since the drilling fluid is non-compressible, the reduction of volume must take place in the gases carried in the mud, the gas volume being measured by calibrating the plunger or reading direct from the scale.

The volume is considered as being composed of a volume of non-compressible fluid and a volume of compressible gas. The initial pressure is atmospheric. By advancing the calibrated plunger through the packing gland and into the chamber, the pressure within is increased. Since the determination may be made in a few seconds, temperature changes are negligible and remain at the equilibrium established by continuous mud-flow through the instrument until a determination is begun.

Since the volume of the cylinder is constant, if the pressure ratio be held constant, the percentage of gas is in direct proportion to the volume of the plunger which enters the chamber. Thus direct readings are obtainable, and no calculations need be made.

When the presence of gas is indicated by the gas detector, a check on the mud returns for possible oil content is possible by means of the fluoroscope. Minute quantities of oil, of the order released when penetrating 1 ft. of saturated formation/hr., with 25% porosity, are invisible to the eye, and do not alter the mud as to viscosity or weight within the scope of instruments normally used for these determinations. Such diffusions, however, may be determined by a fluoroscope, utilizing a light-ray functioning in a band of from 2000 to 4250 Ångstrom units, or from the lower limits of violet in the visible spectrum through the range of ultra-violet emanations. Radiations below 3100 Ångstrom units are especially useful in determining oil in drilling mud.

A. H. N.

832.* Modern Field Technique Adopted in Trinidad. Anon. *Oil Wkly*, 12.5.41, **101** (10), 60.—The high-pressure conditions traditionally encountered in Trinidad drilling continue to demand careful attention to mud conditions. Accordingly, the " mud department " to-day is an elaborate and highly specialized scientific activity. Vibrating screens and mud-laboratory equipment are in evidence everywhere. Trinidad pressure conditions have called for muds weighing as much as 130 lb./cu. ft.

Straight hole is also a guide-word of the local operator, and inclination readings with up-to-date equipment are taken at frequent intervals. Even in some of the deepest holes permissible deviation is limited to between 2¼° and 3°. It has been proved

that the time spent in deviation corrections pays full dividends in the end when it becomes necessary to install and maintain pumping equipment or to correct faulty pipe settings.

The average drilling depth in Trinidad is between 3000 and 4000 ft., but several wells are going down to the deeper horizons, between 6000 and 8000 ft., with regularity.

Much experimenting has been done with various types of screen-liners and fine-gauge wire-wrapped screen-pipe. Recently attempts were made to pack the production section with prepared gravel. This has not been tried sufficiently to reveal what benefits may result when properly applied.

More recently the pre-packed gravel liner has been considered. Several new wells in different fields are scheduled to be produced with this completion method. These liners will be set either in open hole or within perforated casting. A. H. N.

833.* Unitizing Speeds up Operations on Highly Portable Unit. G. M. Wilson. *Oil Wkly*, 23.6.41, **102** (3), 14–18.—The unit consists of three major pieces, each mounted as a self-contained, separate unit on track-laying wheels, that permit them to be moved by tractor from one location to another. When spotted and joined together on the location, each unit becomes an integral part of a smoothly functioning assembly that is definitely aiding in lowering the transportation and drilling costs of each well.

The three principal units are essentially: an 87-ft., specially built derrick with an 18-ft. base, and draw-works powered with a 185-h.p. butane engine; a 40-ft. long by 16-ft. wide pipe-rack connected to the derrick on the side opposite to the draw-works; and the mud-pump unit, consisting of a 7¼ by 14 power pump and a 185-h.p. butane engine, mud-section line, and mixing gun. A fourth unit—a 20-ft. long by 8-ft. wide dog-house, containing lockers, lavatory, and desk—was not mounted on track-laying wheels, but was carried on two large, steel-spoked, flat steel wheels.

With the exception of the fourth unit, each of the units has a steering end, to which is attached a sturdy draw-bar to be used by the tractor for pulling and manœuvring of the unit. A large-diameter king-pin made from a section of 9⅝-in. 40-lb. casing, about which the front trucks turn as a steering unit, provides a large bearing surface and results in easy control of each unit while being moved.

Each component is described, together with the method of moving and installing it.

While only five or six wells have been drilled with this unit up to the time of the paper being written, proof of the initial success of the original intentions of the design may be seen in the fact that all four units, including butane tank and several miscellaneous items, have been moved completely and spotted at the next location in approximately 2½ hrs. This does not include the time consumed in the preparing and breaking-down ready to move. After the drill-pipe is laid down on the rack ordinarily it takes only 2–3 hrs. to disconnect hoses, lay down the travelling block, break out and load-surface mud, water, and fuel lines, and disconnect the units preparatory to moving.

A. H. N.

834.* High-Speed Drilling Chain Paces Deep-Hole Demands. E. Sterrett. *Oil Wkly*, 30.6.41, **102** (4), 35–40.—On the A.P.I.-4 chain the controlling dimension may be taken as the 1¾-in. outside diameter of the roller. Within this limit must be provided metal for the roller, with thickness sufficient to permit heat-treatment and to withstand peening and flattening under service impacts; the bushing, sturdy enough to maintain spacing between side-plates and provide necessary rigidity against twisting or spiraling, and thick enough to permit finishing and hardening against wear on both inside and outside cylindrical surfaces; and the pin, large enough to present adequate bearing surface for its working contact with the bushing, of sufficient diameter to resist shearing at the side-plates, and possessing ample rigidity to maintain true cylindrical form under heaviest loads. In addition to the material or metal requirements for the three working units within this 1¾-in. circle, provision must be included for two clearances—between roller and bushing and between bushing and pin—if the link is to secure the lubrication enabling it to give maximum service life.

With dimensions of stronger chain rigidly circumscribed by specifications and existing clearances in draw-works and rotary drives, chain manufacturers have carried oven further their investigations into the suitability of special alloy steels of highest physical properties, and have adapted their designs to utilize the best materials available. That this search has been successful is proved by the ability of a chain weighing

16·5 lb./running ft. to carry an ultimate strength rating of 185,000 lb. with ample safety factor to meet any rig emergency.

How these results were achieved is discussed in some detail and the paper is illustrated by the chief types of chain as marketed by different manufacturers. Methods of handling the chain to ensure maximum utility and minimum cost are also given.

A. H. N.

835.* Factors to be Considered in Determining Proper Casing Size. L. E. Porter, *Oil Wkly*, 14.7.41, **102** (6), 81.—After reviewing previous opinions, the author considers the following as essential factors which should be considered in any casing programme: (1) The thickness of oil-zones to be produced should be ascertained, differentiation between wells of, say, 100 ft. or less with those engaging several hundred feet of zone open for oil and gas production. (2) The cost and drilling time for various hole sizes should be ascertained as one of the factors in selecting the primary string (water string). (3) Proper regard to the existence of high-pressure gas horizons between the shoe of the surface string and the shoe of the primary water string, and their respective influence, if any, on hole size, mud weight, etc. (4) Determination of the characteristics of the producing zones, as to whether it is advisable to set the primary strings at the top of the producing horizon prior to drilling into them. In this connection added consideration should also be given to: (*a*) the drilling costs for the size of the hole to be drilled in the producing zone, inclusive of core recovery, if coring is to be done; (*b*) the relative efficiency of the hole to be drilled on the ability to perform future remedial work, deepening, etc., subsequent to the original completion; (*c*) costs with respect to future (*b*) above; (*d*) the influence of drilling fluids on the section of zone to be produced, and whether by setting at the top of the producing zone prior to entering a complete change-over of drilling fluid is warranted, so that a lighter-weight fluid, nearer the hydrostatic pressure of the formation, can be used.

If the zone to be produced is affected by drilling fluids, the time element for keeping the hole open to such fluids should be held to a minimum. This should be axiomatic.

(5) Advantages of larger-hole size (if any, within practical limitation of size) over the small-bore hole in future oil and gas recovery. (6) The mechanical influence of the size of oil-strings and liners on future production methods, particularly with respect to: (*a*) special gas lift and flow devices; (*b*) existing pumping methods for deep-well production; (*c*) size of tubing, etc., under conditions of "waxing," as well as flow friction with long strings.

(7) The mechanical flexibility of various casing combinations which will permit cementing through perforations to exclude certain high-pressure gas zones, retaining them for future production or natural gas-lift purposes when the present zones have been depleted to the point that the oil content can no longer be "flowing" or produced by mechanical means. (8) In "high" gas-oil ratio wells involving several hundred feet of zone, due consideration should be given to casing sizes, so as to permit mechanical flexibility (this problem is related to (6) above for controlling gas-oil ratios by means of: tubing size; packer-type flow devices; bottom-hole beans).

(9) The influence of hole and casing size during the pumping stage of a well, particularly with respect to the operator's ability to clean out sand, bailing operations, etc.; see (4) above. (10) The application of the law of averages of casing failures and the necessity of plugging operations, as may be determined from a study of operating conditions in similar fields at similar depths.

A. H. N.

836.* Speed and Mobility have Lowered Drilling Costs. Anon. *Oil Wkly*, 14.7.41, **102** (6), 86.—Lower cost of rotary drilling has been achieved without radical technique or machinery changes, but through gradual refinement of methods used previously, that have improved the efficiency of modern rigs many-fold. To make hole the bit must be rotating on bottom. All other rig operations are non-productive. The trend in modern drilling practice and equipment has been to increase the time spent on bottom actually digging hole, to dig more hole/hr., and to provide for faster dismantling, moving, and erection of rigs. Thus non-productive drilling time has been reduced to a minimum and productive time has been boosted to a maximum. Additional savings have been attained through use of fewer and smaller casing strings, longer service life of modern equipment, and many other factors, but all have contributed to improve

efficiency. Many of the advancements considered individually have been small, but aggregate effect has been large.

Costs have been reduced in many instances by eliminating some of the "unnecessary" drilling. For example, the Gulf Coast area, once noted for close spacing, has developed many fields on 20- and even 40-acre spacing patterns in recent years; and the State of New Mexico has 3000 wells on 40-acre spacing. Similar trends may be found in many other regions. The drilling of fewer wells/acre lessens the capital investment required to develop a property, and consequently smaller quantities of production are needed to make it a profitable enterprise. However, actual reduction of well costs has been of greater and wider benefit, for it has lessened the investment in those tests that have been drilled.

A detailed review of recent practices is given. A. H. N.

837.* Drilling-Bit Performance in California Operations. W. A. Sawdon. *Petrol. Engr*, May 1941, **12** (8), 23–26.—It would appear from present observation that, everything else being equal, hole below the surface string being drilled with rock-bits will go faster with larger bits (within a range of 10¼–12¼ in.), and it is safe to say that the driller can run harder on the larger bits. To state this as a rule would be unwise, however, for the personal element enters into the operation.

An instrument of recent use gives on one record sheet the rate of penetration, the weight carried on the bit, the rotating speed, the circulating pressure, and the torque. This instrument has been in service for too short a time to provide adequate data on its application for determination of bit performance, but it appears to offer opportunities for observing the rate of penetration under variations of rotating speed, weight, and pump pressure. As the records are correlated on the one sheet by time intervals, the effect of any change in weight, speed, or pressure should immediately be reflected by the rate of penetration if such changes actually affect the rate. The rate of penetration is affected by the condition of the bit, hence bit wear must be taken into consideration.

Wear of bits in Californian drilling is studied and certain comparisons are made. Co-ordination of rotating speed and weight carried on the bit has probably been the secret of most effective bit performance; yet, although high rotation generally requires a corresponding reduction in weight, there have been numerous cases where the weight carried with speeds of 400 r.p.m. and over has been greater than is generally considered feasible. This has been so while drilling a number of the wells at Rio Bravo, and the mud circulation having been great in such cases, the possibility of the influence of the circulating fluid should not be overlooked. Correlation of rotating speed and weight with circulation pressure and volume should thus possibly be given greater attention for the particular formation being drilled.

The theoretical wear on bearings is proportional to the speed in r.p.m. multiplied by the square root of the weight carried on the bit. The result of this computation is not a figure of measurement, but rather one for the purpose of comparison.

A. H. N.

838.* Three-Cylinder Slush-Pump for Deep-Hole Circulation. W. A. Sawdon. *Petrol. Engr*, May 1941, **12** (8), 38.—The one pump now in service is an 18-in. by 7-in. by 20-in., and although it has been employed for the drilling of only two wells to date, its use has supplied data that indicate the scope of its performance under operating conditions.

The primary objects of the three-cylinder design are to provide for high pressures without compounding and to circulate a large volume of fluid with one pump. By using three cylinders there is also an overlapping of strokes, and this is apparently the reason for the smooth action and elimination of pounding in operation.

Although the pump is rated as having 7-in. cylinders, 7¼-in. liners can be used. In the two wells thus far drilled with the pump, however, only 6-in. liners have been employed. With liners of this size, circulating at a pressure of 2500 lb./sq. in. and running at 48 r.p.m. (an r.p.m. being considered as a complete stroke forward and back) the calculated volume of fluid pumped was 640 gal./min., based on operating conditions. When a 7-in. liner is used and the pump run at 50 r.p.m. with 300-lb. steam against a pressure of 2000 lb./sq. in., the rated capacity is 930 gal./min.

After describing certain parts in some detail it is noted that there has been no trouble in maintaining pressure in the boilers. The boiler-plants used have consisted of 350-lb. superheated steam units, but steam at the manifold has usually ranged from 250 to 300 lb. The pump has been able to circulate more fluid than could be used, and the average speed has been approximately 40 r.p.m. At one time it was operated against a pressure of 2800 lb./sq. in. at a speed of 40–45 r.p.m. A. H. N.

839.* Two-Engine Drilling Rig Layout Achieves Flexibility in Streamline Arrangement. H. L. Flood. *Petrol. Engr*, May 1941, **12** (8), 43.—Departing somewhat from usual design, the two engines are mounted side by side just back of the hoist, with the crankshafts at right angles to the drumshaft of the hoist instead of parallel to it.

The drive-shafts on both engines are each equipped with two V-belt pulleys. The pulleys farthest from the engines are joined by V-belts, and serve to compound the engines when this is desired. The other pulley on the shaft of the right engine drives the mud-pump. The pulley on the shaft of the left engine drives the central shaft transmitting power to the draw-works and the rotary table.

On the central shaft a gear-box situated just back of the draw-works serves as a take-off for the shaft on which is attached the sprocket driving the hoist via a chain drive. The central shaft continues through the gear-box and extends under the drum to the front side of the draw-works to serve as a direct drive for the rotary table.

A small d.c. generator mounted on the back member of the transmission framework is driven by V-belt from the right engine shaft. When the engines are not running, lights are supplied by a small-engine light-plant.

The central shaft extends only far enough in front of the draw-works to permit a universal joint to be mounted. On the rotary table shaft another universal joint is mounted, and the removable drive-shaft is flanged between the two universal joints. Mounted in the centre of the drive-shaft is a splined coupling that permits the length of the shaft to be shortened or lengthened approximately 6 in. The two universal joints and the splined coupling provide considerable flexibility in placing the table with respect to the draw-works.

Speed variation, engine characteristics, and arrangement are briefly studied.
A. H. N.

840.* Functional Analysis of the Engineer's Place in the Petroleum Industry. Part 3. E. N. Kemler. *Petrol. Engr*, May 1941, **12** (8), 58.—In this part of the paper the duties of the petroleum engineer—amongst other engineers—are described both in the field of drilling and in that of production. Although the chemist makes recommendations for certain special mud conditioning, the petroleum engineer should follow the mud conditioning in the field and see that it is doing what is required of it. The importance of proper mud conditioning even for routine drilling makes it necessary for the engineers to specify what constitutes proper mud conditioning and to set up control methods.

Core analysis, the correlating of drilling and geological information, and the analysis of electric logs are very important functions of the petroleum engineer. As the proper analysis of this information may mean the difference between a successful completion or a poor well, or, in case of wildcat or semi-wildcat wells, may mean the location of, or passing up of profitable production, it deserves the most intensive study.

The study of reservoir performance as a basis for imparting information on reservoirs, type of reservoir, best method of operating reservoir to obtain most economical recovery, and possible advantage of pressure maintenance is an important function of the petroleum engineer. He should have the responsibility and authority to pass on all these important engineering problems. As the best method may not always be applicable, because of methods used by offset operators, or because of proration or other State regulations, his recommendations necessarily have to be passed on to see that they fit other requirements as well as company policy.

The duties of the chemical, mechanical, and civil engineer are also described.
A. H. N.

841.* Diesel-Electric Rigs in Gulf Coast Service. O. Adams. *Petrol. Engr*, June 1941, **12** (9), 36.—Two diesel-electric rigs (known as No. 1 and No. 6) are described in detail, and these are mounted on barges for operation in the marshy coastal regions in the

Mississippi Delta sections of Louisiana. The original equipment on each rig comprised a total of 400-kw. generating capacity and two diesel engines. The generating unit for rig No. 1 comprised two 200-kw. generators on a common shaft, to which two diesel engines were connected through V-belts. The original generating unit on rig No. 6 was a 400-kw. generator connected by V-belts to two diesel engines. To each of these rigs were later added two diesel-generating sets, the engines being direct-connected to the generators, making four engines on each rig, giving each drilling rig 800-kw. generating capacity.

The practicability of the diesel-electric rig may be credited to two factors: the development of the present-day high-speed diesel engine of adequate size, and the perfection of the variable voltage transmission.

The generators are not only variable-voltage generators, but they also have a characteristic voltage curve that falls to zero at some pre-determined current value. This has for its purpose the following: (1) the peak-generator output, and consequently the peak demand on the engines, is limited to the maximum output of the diesel engine. (2) Once this limit is established the protection of the engine against overload is automatic, regardless of the table, pump, or hook-load. (3) The maximum current when the motor is stalled is limited to that value which is safe for the mechanical and electrical equipment, a limitation that is essential for mud-pump and table-drives.

Characteristics of various parts of the rigs are given in general, and it appears that the operation of these rigs in the Mississippi Delta on barges under conditions that provide a wide range of flexibility and adaptability and performance tests indicate adequacy of this type of equipment. On such locations completely self-contained rigs, having high flexibility and reliability, are a necessity. A. H. N.

842.* Service Record of West Texas Drilling Rig to Date. H. L. Flood. *Petrol. Engr*, June 1941, **12** (9), 46.—Taking the view that during emergency periods essential parts of rigs may be difficult to replace, the author details the actual performance of a particular rig, stressing especially the lack of repair expense and downtime due to mechanical trouble, in order to bring out the durability of modern equipment when properly serviced and operated. The wells drilled to date and the difficulties encountered are described, and it is stated that after severe testing in actual practice measured wear is very small in all parts of the rig. A. H. N.

843.* Piling Substructure for Open-Water Drilling Location in Gulf. I. W. Alcorn. *Petrol. Engr*, Midyear 1941, **12** (10), 29.—Substructures for derrick and machinery are formidable items entering into the cost of drilling operations in open waters of the Gulf of Mexico. As regards the design of such structures, local conditions must be taken into account, but experience is also a very desirable aid in arriving at a suitable and economical design.

Such experience with similar structures was an important factor governing the design of a piling substructure for a well 9000 ft. offshore in about 18 ft. of water (mean low tide) at an open-water location in the Creole Area, Cameron Parish, Louisiana, on the Gulf of Mexico. The entire substructure and the arrangement of all machinery and equipment thereon were developed largely from experience gained on a combination barge and piling substructure used on an inland-water location in the Louisiana Gulf Coast.

For the piling structure under discussion, the design called for the use of a diesel-electric drilling rig, consisting of two 350-h.p. diesel engines connected to a common generator.

The rest of the short paper is a discussion of details of the design. A. H. N.

844.* Hard-Facing Tool-Joints as Practised in Mid-Continent Area. H. L. Flood. *Petrol. Engr*, Midyear 1941, **12** (10), 70.—The application of hard metal to the surface of a tool-joint to resist abrasion is only one of the factors in rebuilding a worn joint. It is usually desirable to regain the original gauge diameter of the joint, even to increase its effective diameter over part or all the length of the joint, and nearly always it is essential to restore the square or tapered elevator shoulder to its original contour.

When the depth of the metal to be deposited exceeds $\frac{1}{4}$—$\frac{1}{8}$ in. it is desirable to use

a semi-hard metal. This is not so much to reduce the amount of the more expensive hard metal used, but a composite metal build-up is tougher and less subject to cracking or shattering.

The methods used are many, and only a certain number of these are described.

Some inexplicable actions have been observed as a result of hard-facing in certain ways. When the hard metal has been applied to elevator shoulders, particularly when the joint has been recessed, the surfaces of the joint adjacent to the hard metal will become worn, so that a concave ring or groove is formed. This action is not noted when the hard metal is applied without recessing.

When the weld metal is applied by the arc-welding method, it is highly important to preheat the joint to a minimum temperature of 300° F. This heat can be determined with sufficient accuracy in the field by established methods.

When the weld metal is applied with a welding torch, preheating is not necessary, but it is important to heat the joint uniformly. Beads run circumferentially, with successive beads begun on the opposite side from the one just finished, will aid in uniform heat distribution.

A. H. N.

845.* Portable Drilling Equipment—Design Features and Performance Data. W. A. Sawdon. *Petrol. Engr*, Midyear 1941, **12** (10), 92.—Considering the present application of portable rotary drilling rigs, economy of transportation and decrease of rigging-up time are probably the outstanding features. Both new wells and re-drilling or deepening operations are now being done with portable outfits, and the performance possible during the drilling of a new well is indicated by an example given later, that shows the adaptability of a portable rig in meeting a variety of requirements. In drilling new wells a further economy can be obtained by planning the site to take care of production equipment as well as the portable drilling rig. This is true whether a derrick or portable mast is to be used for the drilling operations.

The adaptability of portable equipment both for drilling and repair or clean-out operations is discussed in some detail.

To illustrate the performance of such rigs the drilling of a typical well is studied. Although the total depth was slightly less than 3000 ft., the operation included wall-scraping the hole and gravel-packing the liner by the reverse circulation method after it was run.

A 122-ft. steel derrick was used for the drilling operations. The hoist was of the heavy-duty type and powered by a 220-h.p. gas engine. The draw-works-engine unit was permanently mounted on a truck equipped with self-contained tracks that provided for moving the unit outward a few feet to obtain partial support on the derrick floor, where it was anchored to tie-bolts set in a concrete production mat previously built below the derrick floor. Mud was circulated by a 7¼-in. by 12-in. mud-pump driven by a gas-engine.

The well was completed in a total of 14 days with the following time distribution: drilling, 4 days; coring, 2 days; reaming, 1 day; running casing, testing, etc., 3 days; wall scraping, 2 days; gravel packing, washing perforations, 1 day; running tubing, rigging up pump, 1 day; total drilling time on bottom, 46·00 hrs.; total coring time on bottom, 10·75 hrs. (Total, 56·75 hrs.) The well was completed with 3-in. tubing set at 2740 ft.

Other details are given.

A. H. N.

846.* Obtaining Subsurface Pressure Records. E. Moore. *Petrol. Engr*, Midyear 1941, **12** (10), 181.—To obtain full value from pressure records, small changes should be readable, and it is seldom that a pressure recorder designed to cover the wide range necessary for all types of jobs will clearly define slight variations at low pressures that are frequently required to disclose the true conditions. A pump gauge has therefore been developed that employs two pen arms actuated by a single pressure element.

By means of this instrument small changes in pressure over a range of from zero to 2000 lb./sq. in. are clearly defined by one pen that travels over the full face of the chart. When the pressure exceeds 2000 lb./sq. in. a second pen takes over and records pressures from 2000 to 6000 lb./sq. in. One instrument can thus be installed on any cementing or acid truck, or otherwise placed in the circulating system to give

close readings at lower pressures and then continue to record the higher pressures when the job requires a wide range.

The adaptability of the instrument to cementing, acidizing, and washing jobs is illustrated. A. H. N.

847.* Detailed Knowledge Guide to Drilling Progress. R. W. McIlvain. *World Petrol.*, June 1941, **12** (6), 40–41.—This paper forms the first of a series published as a symposium on drilling in the present issue of *World Petroleum*. The general thesis of the paper is that shallow fields have been exploited. Therefore, in order to meet the ever-increasing demand for current consumption, and to provide an adequate back-log of available reserves to meet all contingencies, it has become necessary to carry exploration to much greater depths. This, of course, means increased development costs. With an unsatisfactory price level for crude oil and its products in effect for most of the last 20 years, with the tremendous tax burden imposed on the industry, and the further complication of increased costs which necessarily result from deeper drilling, the oil producer has, of necessity, had to devote a great amount of time, effort, and money to devising and providing equipment and methods to meet conditions with which he has been confronted. As a result of this effort substantial progress has been made in improving drilling machinery and technique and in effecting a reduction in overall drilling costs. An investigation of the records of a number of wells in the Mid-Continent area shows the distribution of expenses for drilling alone to be approximately as follows: labour, 34%; bits, 20%; supplies and repairs, 19%; fuel, 8%; depreciation, 16·5%; moving 2·5%.

It is evident from the above that drilling costs may be reduced substantially if drilling time can be further decreased. Factors influencing drilling time include hole size, speed of rotation, weight on the bit, physical properties of mud-laden fluid, and the rate of circulation, as well as the use of suitable equipment in the form of mud-pumps, draw-works, and a rig layout.

These several items are discussed generally. A. H. N.

848.* Prime Movers in Economic Drilling. A. H. Bell. *World Petrol.*, June 1941, **12** (6), 42.—This is a short paper pointing out that many operators think of the drilling conditions of the well as causing damage or failure of the drilling equipment, but it is actually the prime movers that cause the damage. The substantial savings in fuel, water, and installation costs that accrue from the use of combustion-engine rigs are fast putting the manufacturers of steam-driven equipment in a precarious position to defend their markets.

It is the opinion of the author that this situation can be reversed if these manufacturers will completely revise their designing policies, and develop equipment having small prime movers with maximum cut-off for economy of steam consumption and horse-power equivalent to the combustion engines now in use. Recent performance comparisons between steam and combustion-engine rigs in the same field have demonstrated that many steam outfits are greatly overpowered. A. H. N.

849.* Preplanning Aids Economical Drilling. L. E. Porter. *World Petrol.*, June 1941, **12** (6), 43–44.—To obtain greater speed in drilling under safe conditions and at less cost it is urged that resort should be made to (*a*) a continued application of the proper design of adequate drilling equipment for the work to be done; (*b*) a continued increase of efficiency through promoting more orderly development; (*c*) a continued application of practical engineering supervision for such phases as machinery design, mud control, and the proper interpretation of the underground physical forces to be overcome.

A recent study made in California showed all sizes and types of casing and hole sizes to reach the same objective. Variations of casing programmes by the same operators were noted from one field to another—in fact, all types of inconsistencies. This brings out the point that too few operators, in selecting the size hole to be drilled and casing size to be set, approach the matter as a programme to be pre-analysed, taking into consideration: (*a*) the long-term economic outlook of the field; (*b*) the sub-surface conditions to be overcome; (*c*) the effects of hole size on the recovery of oil, if any; (*d*) the initial cost; (*e*) the ultimate cost.

In addition to the above, consideration should be given to the ultimate advantage, which, of course, will include the maximum returns for the least expenditure of money and the advantage gained in the production of the well throughout its life, in the movement of production tools in and out of the hole, and in the handling of production-flow devices and adequate-size pumping equipment in and out of the hole. A. H. N.

850.* Deeper Drilling has Encouraged Improved Method. H. M. Staggs. *World Petrol.*, June 1941, **12** (6), 45.—During the past 12 or 15 years drilling speed has been increased by 100%, whilst fishing jobs have been decreased by more than 50%. At the same time, drilling contract prices in deeper drilling have been reduced by 30%, and in the shallower areas by 50% or more. Holes are drilled much straighter, are better cased, and better cemented. Records of all kinds are kept much more accurately, wells are better completed, and accidents connected with drilling operations have been very materially decreased. Problems coming up as deeper drilling has been required have been met and either partly or wholly solved. This has cleared the path for further progress in improved drilling practice.

The trend to-day is towards making a drilling operation, either exploratory or development, a completely planned operation. This planning is done by engineers having knowledge of drilling equipment and the difficulties connected therewith, as well as the timely use of specialized services in logging, mud, cementing, and other such services.

Several improvements and trends in deep drilling are mentioned. Long liners, 3000 ft. or more in length, are being successfully used to reduce casing requirements. These liners are being cemented from the bottom to a short distance above the base of the next larger string of pipe. These liners take the place of string of casing, which necessarily continues all the way to the surface. Deeper drilling has brought about the use of progressively heavier drilling machinery and more power, and drilling speeds far in excess of those of a few years ago. A. H. N.

851.* Economies in Selected Casing. E. A. Jenkins. *World Petrol.*, June 1941, **12** (6), 49.—This short article deals with the choice of casing sizes—especially in mixed strings—to yield most economic conditions. Not only the cost of casing but producing conditions and problems must also be considered in choosing casing sizes. As a further economy, two-zone completions are becoming more common—that is, two separate producing horizons are tapped and produced through a common drill-hole and string of casing. This is accomplished by setting the casing on or through the lowest producing formation, and then perforating or milling out the section of casing adjacent to an upper productive zone. Then by setting a packer between the zones they may be produced; one through a tubing string, and the other through the annular space, or through two strings of tubing in the same well. A. H. N.

852.* Trends in Deep-Drilling Equipment and Practice. A. G. Levy. *World Petrol.*, June 1941, **12** (6), 50–51.—An extremely concise statement of the trends in all parts of drilling equipment and practice is presented under short and separate sections. Steam remains the most flexible and reliable power available. Internal-combustion power (gas, gasoline, butane, or diesel), whether converted into electric power or not, is definitely indicated where free or very cheap gas is not available, or where water is scarce. The trend in draw-works is towards oil-bath units, completely enclosed—the sprockets forced and precision cut and the chains of the high-precision type. That in swivels and rotaries, as well as crown-blocks and travelling blocks, is towards higher capacities at increasingly high speeds. The trend in mud-pumps is towards greater volumes at higher pressures. In steam-engine design it is towards more power and higher speeds. In internal-combustion engines the trend is definitely towards heavy-duty diesels. In drill-pipe it is towards streamlining, inside and outside, together with the use of higher-yield steels. Pipe-weight indicators are on all rigs. There has been a tendency to try to find a suitable substitute for barytes as a weighting material for drilling muds. Starches are being used experimentally and practically in certain localities as an additive to clay-base muds, partly as a

substitute for bentonite in reduction of free water, but more particularly in connection with muds of high saline content.

The trend in chemical treatment is more and more in the direction of the polyphosphates, with sodium-tetraphosphate probably the most generally used. That in cement is towards a retarded setting under conditions of high temperatures and pressures. Preventive squeeze jobs are becoming increasingly common prior to gun-perforating for production wherever water is present close to the objective horizon, and wherever there is reason to believe that the original cementing may be faulty or inadequate. Stage cementing has been advocated, and used more or less for some time. Wall-cleaners are being used more extensively of late, particularly spring-wire contraptions fixed to the outer wall of the casing for the purpose of removing competent filter-cakes and centring prior to the placing of cement. A. H. N.

853.* **Trend to Pressure Maintenance.** J. H. Abernathy. *World Petrol.*, June 1941, 12 (6), 53.—Although producers are beginning to consider the gas compressor as a conventional equipment item, with a few notable exceptions the general practice is to defer the installation of high-pressure equipment, and await the day when repressuring may be utilized, since pressures are decreased by long production, and equipment can be installed at much lower cost. Many hold the opinion that under present low allowables and long pay-outs it is better to reduce capital investment to a minimum, even at a sacrifice of some efficiency in the distant future. The point made here is that the delay may result in cheaper installation, at great sacrifice to ultimate recovery.

These impressions are current because little information has been available dealing directly with the relative efficiencies of repressuring and pressure maintenance. It can be demonstrated that in many gas-control reservoirs where repressuring will add from 20 to 50% to primary recovery, pressure maintenance will add 75% or more. This means that for an investment of probably not exceeding 10% of well cost, a direct addition to producible reserves of 25–50% is obtained. Pressure maintenance has also an advantage as compared with repressuring in that productive capacities of affected wells are sustained at high levels over much longer periods of time. This may be of greater importance to the country than increasing ultimate recoveries, because it may be necessary to meet war-time demands at short notice. A. H. N.

854.* **Facts to Face in Future Drilling.** E. K. Parks. *World Petrol.*, June 1941, 12 (6), 57–63.—A statistical study of drilling and its relation to the industry as a whole is made. A special detailed analysis of reducing drilling costs is made and illustrated by typical cases from practice. Comparison of gas, steam, and electric power for drilling is given. The advantages of electric power are listed as: (1) Low operating cost. Records from actual installations show that electric power is much less costly than steam power for a rig of comparable size and drilling under the same conditions. (2) Maintenance costs are extremely low. (3) Moving and set-up time are short, and therefore the cost of moving an electric rig is much lower than that of a steam rig of corresponding size. (4) The life of the equipment is extremely long. There are many electric rigs in operation in California and other fields which are 12–15 years old and are still in daily operation. (5) Capital investments are reasonable, although they may be somewhat higher than in the case of a steam equipment. However, the low cost of maintenance, operating cost, and the saving due to short set-up time, and cost of moving, quickly offset the difference in capital investment. The main reason for the higher cost of a.c. electrical drilling rigs is due to the high cost of power-pumps. It is hoped that recent developments will result in new types of mud-pumps which will materially reduce the cost of power-pumps.

Similarly the advantages of a d.c. drilling equipment are given as: (1) its characteristics are so designed that it is impossible to impose loads on prime movers greater than they can carry, thus definitely preventing their being stalled. (2) It has speed characteristics like the steam engine, thus giving a wide range in speed and torque for the draw-works and a positive indication of any restriction or stoppage in the mud-pump line. (3) It makes available the combined capacity of the mud-pump and draw-works power supply for heavy hoisting duty when coming out of and going into the hole. (4) It provides individual control of drilling and mud-pump

operations, centralizing this control at the driller's stand. (5) It readily provides low table speeds, quick reversals, fast or slow pick-up as required on heavy or light loads, and speeds of the empty hook as high as the crew can handle. A. H. N.

855.* Internal-Combustion Drilling Rigs. F. C. Ripley, Jr. *World Petrol.*, June 1941, **12** (6), 76–79.—Generally speaking, there are three classes of internal-combustion drilling machines on the market to-day. These machines in each class are constructed for the lightest to the heaviest work. The three classes are as follows: (1) the converted steam rig; (2) the custom-built machine; and (3) the unit-type power-rig. The converted and custom-built rigs are quite similar in construction, and could probably be considered as being of one class. These machines are doubtless the most versatile now on the market as far as meeting construction demands by the customer is concerned.

The custom-built or the adaptation from steam-rigs has many characteristics in common with the older type of equipment. Vast improvements, however, have been made in both the design and operation of the machine, and the present models are therefore thoroughly up to date for the purpose they are intended to fulfil.

Fundamentally, the machines consist of a standard multiple jaw or friction-clutch draw-works which is usually equipped with double-clutch sprockets on the jackshaft which raises it from the regular three- or four-speed to six- or eight-speed. Behind this draw-works is a master forward friction clutch and reverse-gear driven from a totally enclosed flood-lubricated compound transmission case. Coupled into this case are two or three engines of any aggregate horse-power, limited only by the capacity of the forward clutch.

These machines are called custom-built because with this design it is possible to meet a number of requirements at the customer's suggestion. The draw-works may be raised to as much as 12 ft. above the ground, whilst the engines remain at ground, or low substructure level. Any make of engine desired by the customer can be used with an aggregate horse-power and speed compatible with the capacity of the master clutch and compounds. Many operators prefer to use as much of their steam equipment as possible. In this case a regular four-speed steam draw-works can be cheaply changed over to six- to eight-speed, and can be used with the reverse clutch and compound transmission with complete satisfaction.

For rule-of-thumb comparison of horse-power ratios for depths compatible with steam-drilling time, it might be said that 275 h.p. is sufficient for 3500 ft. of 4½-in drill-pipe; 450 h.p. for 4500–6000 ft.; 600 h.p. for 6000–7500 ft.; 800 h.p. for 7500–8500 ft.; 1000 h.p. for 8500–10,500 ft.

Comparative studies are made of these engines and rigs and of corresponding steam-rigs. A. H. N.

856.* Barge Mounted Diesel Electric Rigs. A. H. Rowan and H. E. Dralle. *World Petrol.*, June 1941, **12** (6), 80–84.—As most commonly used, a variable voltage equipment comprises several direct-current generators of medium capacity, up to 250 k.w., for direct connection or belting to gas or diesel engines, complete with voltage-varying control for supplying power to the operating motors driving the draw-works, table, and mud-pumps on a rotary drilling rig. This form of drive has been time-tested and proved in rotary drilling as one of the most reliable, flexible, and economical in providing a smooth, even flow of power to the operating equipment. To obtain these features there are two methods of operating the generators: series and parallel. These are discussed and compared.

As the number of generating units is increased above two, and on these large rigs there are four generators, the overall advantages considered from the standpoints of practical voltages, generator designs, standardization of parts, simplicity of control, and economics of application are in favour of the parallel system. The conclusions regarding the fields of application of the two systems are borne out by the large number of successfully operating units of both types.

Variable-voltage electric rigs operating on barges in the Mississippi Delta near La Fitte, Louisiana, employ the parallel system of operation and have engine generator capacity of 800 k.w. (1075 h.p.) for the main drives. There are four generators, each rated 200 k.w., 400 volts, 40° C. Two generators operating at 1200 r.p.m. are

belted and two generators operating at 600 r.p.m. are directly connected to 8-cylinder 9 × 12, 375-h.p., 600-r.p.m. Cooper-Bessemer engines. The reason for using some belted and some direct-connected generators is purely one of economics. Existing equipment was utilized in making up the barge unit. Mechanically it is preferable to use all generators direct connected to their respective engines.

Details and characteristic data are given. A. H. N.

857. Patents on Drilling. C. A. Rasmussen. U.S.P. 2,241,477, 13.5.41. Appl. 14.8.40. Jar having a tubular body.

F. W. Sharp. U.S.P. 2,241,486, 13.5.41. Appl. 9.10.37. Deflecting tool consisting of a stem, a bit and a deflecting member sliding on the stem.

M. Rosenkranz. U.S.P. 2,241,526, 13.5.41. Appl. 12.9.39. Pipe-joint tester.

J. W. Hatcher. U.S.P. 2,241,549, 13.5.41. Appl. 6.2.40. Rotary bit with disc-cutters on four horizontal axles.

R. E. Hendrickson. U.S.P. 2,241,550, 13.5.41. Appl. 24.7.39. High-angle well-surveying instrument.

J. J. McNamara. U.S.P. 2,241,712, 13.5.41. Appl. 7.2.38. Drill.

G. L. Scott and W. B. Noble. U.S.P. 2,241,746, 13.5.41. Appl. 3.4.39. Directional drilling apparatus.

J. V. Ryan and E. S. Davis. U.S.P. 2,241,926, 13.5.41. Appl. 10.11.38. High-pressure hose coupling.

A. L. Noyer and A. McEachern. U.S.P. 2,241,955, 13.5.41. Appl. 16.7.10. Metallic rope and cable.

L. F. Athy and H. R. Prescott. U.S.P. 2,242,161, 13.5.41. Appl. 2.5.38. Method of logging drill-holes by means of a chemical which induces temperature changes in the hole and measuring these changes.

D. W. Watson. U.S.P. 2,242,602, 20.5.41. Appl. 29.9.39. Double duty fishing-tool.

E. G. Leonardon. U.S.P. 2,242,612, 20.5.41. Appl. 25.5.37. Method for determining the beds traversed by drill-holes.

D. M. Smith and L. Newcomb. U.S.P. 2,243,131, 27.5.41. Appl. 10.1.40. Hold-down bearing for rotary.

F. W. Hild. U.S.P. 2,243,340, 27.5.41. Appl. 23.5.38. Rotary blow-out preventer.

B. J. Festervan and N. F. Henderson. U.S.P. 2,243,419, 27.5.41. Appl. 19.10.38. Fishing-tool for pipe-ends.

A. Pranger and S. A. Guiberson. U.S.P. 2,243,439, 27.5.41. Appl. 18.1.38. Pressure drilling-head.

C. S. Cady. U.S.P. 2,244,674, 10.6.41. Appl. 25.3.40. Expanding drill.

E. A. Hartung. U.S.P. 2,244,693, 10.6.41. Appl. 21.10.38. Pipe and pipe flange-tongs.

E. A. Hartung. U.S.P. 2,244,694, 10.6.41. Appl. 31.3.39. Pipe and pipe flange-tongs.

C. J. Gardner. U.S.P. 2,245,128, 10.6.41. Appl. 2.7.40. Drill-pipe cleaner or drier.

T. T. Nudson and W. A. Abegg. U.S.P. 2,245,221, 10.6.41. Appl. 1.7.40. Device for measuring drill-pipe. A. H. N.

Production.

858.* Reconditioning Procedure for Old Wells. Anon. *Petrol. World*, June 1941, **38** (6), 39.—The first problem of the engineer engaged in reconditioning work is to determine whether or not the wells under consideration can again be made profitably productive. The estimation of costs on work of this sort is by no means simple. It requires an intimate understanding of conditions existing at the time the wells were shut in, and those prevailing at the time the reconditioning is contemplated. A complete examination of each well and all its appurtenances must be made, not only to determine the efficiency of the equipment above ground, but as far as possible to define sub-surface conditions.

When a well has been closed down for any protracted period, many things happen. From disuse, everything mechanical tends to approach nearer and nearer to complete obsolescence. Surface equipment becomes weakened by corrosion and other deleterious influences. Underground, the interstices in the oil-sands are gradually filled with encroaching water, which rises into the casing and tubing, slowly scaling up everything with which it comes in contact, and adding inexorably to the difficulties of reconditioning.

As the period of idleness extends, the disintegration progresses, and it becomes the problem of the reconditioning engineer or agent to determine whether or not it has progressed beyond the point of economical rehabilitation. The paper discusses various methods of such studies and the different steps necessary in reconditioning work.

The whole process of reconditioning has been markedly affected by modern trends in both producing and refining practice. Production research has not only stimulated but has greatly aided the development of satisfactory tools for performing the diverse operations required in the repairing and reconditioning process. Chief of these, perhaps, are the portable servicing hoists and derricks, and shaft-driven centrifugal pumps.

Refinery research has led to a reclassification of the various crudes, and has increased the demand for certain types. The effect of this combination of events is further exaggerated by a world condition that demands the ultimate in production.

A. H. N.

859.* Pumping Equipment and Practices in New Illinois Pools. W. C. White and M. A. Sherwood. *Oil Gas J.*, 24.4.41, **39** (50), 69–70. *Paper Presented before American Petroleum Institute.*—During the past four years approximately 9000 wells have been completed in the Illinois basin. To produce the oil discovered therefrom it has been necessary to modernize central powers and individual pumping units. Modern power installations have been made that pump as many as thirty wells in an area 2 miles long and 1 mile wide. Rod-lines are in use having a length of slightly more than 1 mile. The high efficiency obtained by these powers is a result of improved design.

Actual tests reveal that power consumption during the winter months is as much as 30% higher than in summer months. The use of time-switch control has resulted in lower demand on electric-power systems.

Other subjects discussed in detail are the relative advantages and disadvantages of centralized power systems and of individual pumping units. General principles are laid down for the selection of pumping equipment to give minimum installation cost and realize maximum efficiency, especially in areas like Illinois. A. H. N.

860.* Hydraulic-Pneumatic Pumping Unit Tested on Illinois Well. H. F. Simons. *Oil Gas J.*, 15.5.41, **40** (1), 44.—A new type of pumping unit is being tried in the Illinois field, the usual beam and counterbalance being replaced by a hydraulic cylinder and a radial pump for lifting the rods and oil, and an air-chamber for cushioning the downward stroke. Hydraulic pumping units have been tried on deeper wells in other parts of the country, but the equipment being tested probably marks the first time that such a unit has included air-cushioning and has been used on a well of medium depth.

The unit used in the Illinois fields has a 58-in. stroke and normally operates at

18 s.p.m. However, both the length of the stroke and strokes/min. can be increased if desired. The increased length of the stroke makes it possible to reduce the number of strokes/min. and still handle a large volume of fluid. Reduction in the strokes/min. is very helpful in eliminating sucker-rod breakage, as the number of peak loads and the number of reversals of the load are reduced. In nearly 3 years of operation it is claimed that no sucker-rod breakage has been experienced.

The travelling part of the system, including the cylinder and the rods and pump attached to it, moves at a uniform speed upwards, with the exception of about 10% of the distance, which is used for acceleration and deceleration. The speed on the downward stroke is likewise uniform except for the same factors. However, the upstroke and the downstroke are not at the same speed, the cylinder and rods falling much faster than they are raised. The time required for the upstroke thus becomes greater than the average speed of the travelling cylinder.

The weight of the unit, which is capable of a 16,000-lb. load capacity, is less than 3000 lb. It consists of a 50-h.p. 6-cylinder internal-combustion engine driving a 9-cylinder radial pump through V-belts, the hydraulic cylinder and piston, a chamber for storage of the fluid and the air-cushion, and a frame for supporting the vertical and near-vertical members. The skid on which the equipment is mounted is equipped with a ratchet winch so that the pumper can slide the unit back from the wellhead in case servicing machinery is being moved in. A. H. N.

861.* Core-Analysis Interpretation. N. Johnston. *Oil Gas J.*, 22.5.41, **40** (2), 76. *Paper Presented before American Petroleum Institute.*—Core analysis is an attempt to find the amount of space that is available for oil and gas in a subsurface reservoir, how much of this space is actually occupied with oil and gas, and how much with water, how rapidly this oil and gas will be available, how much of it may be recoverable by various means, and how best to design those means of recovery. These several items are studied and correlated.

A laboratory technique has been adopted for measuring porosity of loose sands. A small amount (2 ml.) of kerosine is pipetted accurately into a 50-ml. graduate, and about an equal volume of dry sand is added. This is tamped into a tight pack with a ¼-in. flat-ended rod. The process is continued with about 1 ml. additions of sand and just enough kerosine to fill the sand pores (but no excess), until about 20 ml. of pack has been built. The bulk volume and the kerosine volume allow of a direct calculation of total porosity. By comparison with effective porosity measured by a Kobe porosimeter, this method gives results which must be multiplied by 0·86 to give equivalent effective porosities of very soft but coherent sands.

Porosity and permeability are almost independent physical properties of porous rocks, and are very difficult to estimate visually. Either can change with extreme rapidity along a vertical section, but in general varies less rapidly along the direction of bedding planes. In some uniform sands, correlations may be made between nearby wells by means of either porosity or permeability, the latter being preferred because of the much greater range of values encountered.

Saturation, grain analysis, and chemical tests are briefly discussed.

The bulk of the remainder of the paper deals with the interpretation of these tests to determine the productivity characteristics of sands. The specific productivity index is particularly discussed in detail, and the reasons why theoretical and practical results diverge are analysed, stress being laid on mudding effects, gas-bubble resistance, and resistances caused by interstitial water.

The long paper ends with a discussion of the applicability of the interpretations to completion and production programmes.

It is concluded that core analysis has reached a stage of development in which it is one of the most definite and useful tools we have for the study of reservoir properties. There are many phases of its interpretation which are only semi-quantitative and which definitely merit further intensive study. It is hoped that this discussion may stimulate experimental work along suggested lines, or bring out alternative methods of interpretation which will lead to greater accuracy and a broader usefulness for core analysis. A. H. N.

862.* Pressure-Core Analysis. J. J. Mullane. *Oil Gas J.*, 22.5.41, **40** (2), 118. *Paper Presented before American Petroleum Institute.*—The analytical procedure used

to measure the quantities of interest in a pressure-core analysis may be divided into two parts: (1) the operations performed on the derrick floor; and (2) the operations performed in the laboratory.

When the core-barrel is laid down, it contains the core recovered. All excess volume is filled with drilling mud. The first measurement made is that of the pressure obtained. This pressure should be approximately equal to the hydrostatic head of mud at the coring depth. Its measurement tells whether the barrel has operated properly. Second, the amount of gas contained in the core is measured. This may be free gas, or gas in solution in the oil, or both. A separator and gas-meter are connected to the bleed-off port of the pressure tube. The pressure is then relieved by rupturing a disc, and the gas and liquid are allowed to escape through a valve. The drilling mud and any oil produced are trapped in the separator, and the volume of gas evolved is measured by the meter.

In the laboratory the following quantities are measured: Porosity, permeability, residual oil saturation, residual water saturation, residual salt content of rock as sodium chloride, oil content of drilling mud from core-barrel, salt content of drilling mud from core-barrel, salt content of drilling mud from circulating system, and lump density of dry rock.

In some cases a water-soluble tracer was added to the drilling mud in order to demonstrate the presence of water from the drilling mud in the core and to estimate the amount of such water. Dextrose, a sugar compound, was used for this purpose.

It is shown that a more complete analysis of the core can now be obtained, and that the usefulness of core analysis has been considerably extended. Gas–oil ratio data obtained with the pressure core-barrel have been shown to be in agreement with the production gas–oil ratio as determined in the field.

It has been found that, in addition to gas, both oil and water are contained in cores, even though taken from wells that produce no water. A correlation has been observed between the oil produced from cores taken in a given horizon and the initial potential of the well. At least part of the water produced has been shown to be connate water. With the more complete data obtained with the pressure-core barrel it is believed that more reliable estimates of reserves can now be made from core data. Information as to the mechanism by which cores are polluted by water from the drilling mud is given. Evidence is given to show that two types of invasion are operative. These are: a vertical invasion ahead of the bit, and a radial invasion of the core. A. H. N.

863.* Use of Depth-Pressure Data in the Determination of Well Potentials in California. R. W. French, M. W. Morris, E. G. Trostel, and J. C. Young. *Oil Gas J.*, 22.5.41, **40** (2), 150. *Paper Presented before American Petroleum Institute.*—The paper discusses the operations of depth-pressure since its final approval in November 1939. Data are presented to show the relative accuracy of the test methods, their economic value to the industry, and the degree of their acceptance by operators. Specific problems of an engineering nature have arisen from the interpretation of depth-pressure data; these are discussed, together with the methods of approach used in attempting their solution.

It is shown that well potentials for use as the primary factor in allocation under the California "uniform method" are being successfully established by depth-pressure means in flowing, gas-lift, and pumping wells. Hazards of extrapolating the mean producing pressure-rate curve are discussed, and minimum practicable mean producing pressures are calculated within conservative limits. Present status of special studies is given, covering such topics as critical sand entry, pump capacity *v.* depth, sonic-method tests, hydraulic unit tests, and gradient determination and estimation, both in tubing and in the annulus. Acceptance of the depth-pressure method is general, but there is no evidence of a sudden swing towards it as an alternate to open-flow tests, nor is there any tendency for it to cause inflation of state potential. Incidental value of this work is great in widening the circle of operators familiar with this analytical method and in promoting more general acceptance of reservoir behaviour concepts.

It is concluded that the comprehensive background of carefully compiled data gathered from most fields in the state in connection with the depth-pressure-potential

method should prove valuable if it is systematically reviewed, correctly analysed, and properly applied. A. H. N.

864.* Producing Practices at Red Fish Reef Lessen Offshore Hazards. N. Williams. *Oil Gas J.*, 12.6.41, **40** (5), 36–37.—The project calls for concentration of oil-production handling and flow control through a central separator station. The station is located on a piling-supported structure, the height of which is sufficient to place the separator and operating platform out of reach of the highest tides and waves. No individual separators are placed at any of the wells, and production of all oil-wells is flowed directly to this station.

Sufficient separator capacity for all oil-well production will be provided at this central station, including separators for testing of wells and for regular production. Requirements of the field for the time are being taken care of with one testing separator, two separators for regular production, and one separator for final scrubbing of the gas. A 250-brl. field-tank has been provided for use in cleaning of wells during completion and for emergency storage, but regular production is normally run directly from separators to barges for movement to Cedar Point, at the north end of Galveston Bay, where the company has storage facilities and pipe-line connections. Flow control and manifolding are described.

Each well is equipped with a velocity valve or storm-choke as the first control precaution. This valve protects a well behind the surface chokes and is operative in the event of the Christmas tree proper being broken off or any leaks occurring below the surface chokes. A velocity valve (storm-choke), set in the tubing string at a level usually below the point where there is any likelihood of paraffin formation, functions on a pressure differential principle. The valve is kept open only by the maintenance of a set-back pressure above the choke in relationship to the pressure below the valve. When the pressure above the valve falls below the set minimum, as would occur with a break in surface connection behind the surface choke, the pressure differential would be disturbed and the valve would close. Other precautions are similarly described. A. H. N.

865.* Air-Drive Experiments as Related to Secondary-Recovery Operations. H. Krutter. *Oil Gas J.*, 12.6.41, **40** (5), 49.—Besides porosity and permeability, many other factors enter into the problem of petroleum production. Some of the factors which are important in the secondary-recovery process are the original condition of the field, the depletion of the field during flush production, the rock pressure, the oil saturation, the connate water content, the surface and interfacial forces, the viscosity of the oil, the gas in solution in the oil, the pore pattern in the sand, the horizontal and vertical variation of permeability, the chemical and physical nature of the material coating the sand-grains, and arrangement and spacing of the input and producing wells, the pressures applied and their method of application, and the secondary-drive medium.

The relative permeability to air, $K(s)/K$, is defined as the ratio of the effective permeability to air when the saturation of the core is (s) to the specific permeability (K) to air of the completely extracted core. It is shown that the variation in relative permeability is a function of oil saturation for four runs at inlet pressures varying from about 5 to 30 cm. of Hg. The points all lie within a narrow band. Therefore, within this pressure range the relative permeability–saturation relationship is independent of the pressure applied. The relative permeability for oil saturations up to 20% is essentially equal to 1. This indicates that oil left in the pores of the sand-body is retained in the sharp angles between the sand-grains, and that 20% of the pore volume is comparatively dead space and, therefore, has a negligible effect on the permeability of the sand. The removal of this 20% of oil is essentially an evaporation and entrainment process. These experiments lead to the conclusion that the relative permeability has a definite meaning for a given core, and that this relationship between relative permeability and oil-saturation is independent of the pressure gradients applied and the viscosity of the oil used between the saturation range 0–70% (pressure gradients from 5 cm. of Hg/in. to 30 cm. of Hg/in. and viscosities from 2 to 100 centipoises). At higher oil saturations this relation may break down.

A "threshold pressure" was observed in driving oil by air, below which the oil did not flow. This pressure decreased with an increase in permeability of rock according to

$$P = 18{\cdot}2K^{-0{\cdot}313}$$

Experiments were also performed on oil recovery by air from 100% oil-saturated cores and from cores partly saturated with water and partly with oil. It is concluded that connate water concentration and its distribution in the pores play a controlling part in the amount of oil recovered. A core can produce oil even though the oil saturation is as low as 30%, if connate water is present. This is due to the fact that, although there is only 30% oil, it is contained in the larger-size capillaries, and the connate water is in the smaller capillaries. Consequently, the factor that determines oil recovery to a large degree is the connate-water concentration. It is therefore very important in a core analysis to determine the connate-water content as well as oil saturation for recovery estimates. A. H. N.

866.* New Opelika Recycling Plant Provides Flexible Operation. G. Weber. *Oil Gas J.*, 26.6.41, **40** (7), 46.—The recycling operation at Opelika combines the advantages of exclusive pressure maintenance in the entire field and early operation, begun before reservoir pressure has declined appreciably. The first condition allows operators to carry out an efficient field-injection programme without competition from other similar projects. By providing pressure maintenance early in the field's production history, subsurface condensation is minimized, and a maximum recovery of liquid hydrocarbons will result.

Opelika operations will be of particular interest to recycling engineers. Since the plan incorporates an entire field, the study of residue-gas migration from the injection point will contribute to information on subsurface gas displacement during recycling. The project is the first major operation of its type in a lime reservoir, and as such will furnish important data on recycling to porous lime.

The field development up to date is summarized. Current recycling-plant operation results in a total daily production of 75,000,000–80,000,000 cu. ft. of gas. Shrinkage due to processing and plant use and outside gas sales result in a net withdrawal of 22,000,000–22,000,000 cu. ft. daily. The current withdrawal rate as compared with known reserves of high-pressure gas indicates a long-term plant operation.

A relatively high yield of condensate promises ample return on plant and field investment. In addition, the advantage of early pressure maintenance guarantees maximum recovery of condensate. Field development for recycling under a unitized programme requires far fewer wells than under ordinary well-spacing programmes.

Without recycling it is improbable that the field would justify full development for several years, due to the lack of gas demand in East Texas. Therefore incorporation of the field into a single recycling programme has resulted in greater returns to operators, royalty owners, and tax recipients at a much shorter payout period.

The recycling plant operates at two pressures. About 20,000,000 cu. ft. of the daily intake of 80,000,000 cu. ft. is flashed to a low pressure, and the residue gas is sold to the Loan Star Gas Co. The remaining 60,000,000 cu. ft. is held at high pressure through the absorption process and recompressed for injection. The rest of the paper details the operations. A. H. N.

867.* Increased Recovery by Pressure Maintenance. J. H. Abernathy. *Oil Gas J.*, 26.6.41, **40** (7), 53.—Laboratory data and field operations indicate that the average recovery from a gas-drive reservoir by conventional production methods is in the order of 25% of oil in place (corrected for shrinkage). The balance of the oil is left in the reservoir largely because at about 25% void space the relative permeability of the formation to gas becomes high. Gas–oil ratios go up; the gas is exhausted and the field is considered depleted, although the pay usually retains a quantity of oil substantially in excess of that required to wet the reservoir rock, which is true depletion saturation. Since void space is the controlling factor determining apparent depletion, any operation which reduced the quantity of void left by the production of a barrel of oil adds proportionately to the producible reserves. This is true though the recovery factor may be other than 25%. A sample calculation is presented indicating the magnitude of the void space "saved" by pressure maintenance. For a

hypothetical 4000 ft. Permian Lime reservoir, assuming no free gas, indicated additional recovery by complete pressure maintenance is about 78% of recovery by primary means. It is shown that no part of this 78% can be produced by repressuring. Further calculations have been made, and are presented graphically, showing the additional recovery by pressure maintenance for recovery factors varying from 20% to 40% of oil in place.

Expressed algebraically, the calculations take the following form:

$$Q = \frac{(1 - R) - \left(\frac{1 - R}{S}\right)}{R}$$

R = recovery factor, by primary means. S = shrinkage factor. Q = extra oil to be recovered by pressure maintenance, in per cent. of primary recovery.

Some of the factors which might affect recovery by pressure maintenance are: (1) viscosity; (2) surface tension; (3) quantity of free gas in the reservoir; (4) percentage of connate water; (5) porosity of the formation; (6) permeability of the formation; (7) wettability of the reservoir rock; (8) bottom-hole pressure; (9) temperature; and (10) water drive, if any.

An examination of these items discloses that most of them alter the primary recovery factor and affect pressure maintenance recoveries only indirectly, as calculated. However, the quantity of free gas, the water drive, and the wettability of the reservoir rock should be given special consideration. A. H. N.

868.* Correlation of Field and Laboratory Research in Secondary Oil Recovery. H. R. Pierce. *Oil Gas J.*, 3.7.41, **40** (8), 37.—Some of the research carried out that has resulted in enabling us to prove or disprove some of the most popular conceptions of proper or improper operating technique is as follows:

The most popular fallacy is that in most fields producing efficiency can be increased by back-pressure application. Although many worth-while pools can be made more lucrative, and in many cases more efficient, by designed manipulation, in most pools the recovery efficiencies are irreparably damaged by back-pressuring. Certain types of reservoirs are permanently impaired in efficiency by any method of back-pressuring.

A generally accepted fallacy of secondary recovery application is that most sands are by-passed by having applied to them too much differential from pressure-well to producer. Admitting that this condition can, and sometimes does, exist, simple laboratory technique proves that there have been more sands by-passed and irreparably damaged by starting recovery operations with too low a differential between pressure wells and producers than by starting with too high a differential.

There is continually cropping up the fallacy that a synthetic representation of a sand-body can be reproduced. This is impossible, however, without understanding the wide variation in unit pore-channel permeabilities.

Results prove that more harm is done by copying a neighbour's technique than by any other procedure. Using actual sand-cores, it can be proved in the laboratory that the number and location of wells drilled in any pool are vital to the efficiency and economy of oil and monetary recovery.

By field and laboratory tests, practically accurate saturation of oil-producing reservoirs can be estimated, but there is no method whereby direct readings of sand saturation can be made from core analysis.

By combined field and laboratory tests, sand-pressure gradients, and efficient directional recovery, operations can be established taking into account: (*a*) gas-cap repressuring; (*b*) natural water drives; (*c*) stratified permeability arrangements; (*d*) directional permeability variations; (*e*) directional and accumulative shale or lime sealing effects; (*f*) sand thickening; (*g*) cumulative sealing.

It can be demonstrated conclusively in the laboratory that there is no means of choosing core samples to be tested as representative of the whole section. By simple demonstration on actual cores it can be shown that the so-called differential shooting applied extensively in recovery is inefficient and damaging to the ultimate recovery of oil.

Laboratory tests, when combined with properly conducted field tests, have been devised which give fairly definite indications of the recovery medium which should be used in planned recovery operations and at what time in the life of the pool recovery operations should be applied to get the greatest dollar return.

The recovery of oil by gas recycling combined with limited quantities of water injections is a feasible procedure in some sands, and if properly applied will yield startlingly high dollar recoveries over a long period of application. The method of applying solvents commercially, successfully, and economically to actual sand-bodies in connection with gas-recycling recovery operations has been worked out, and offers many possibilities. A. H. N.

869.* Cotton Valley Section—Recycling in Louisiana. G. Weber. *Oil Gas J.*, 10.7.41, **40** (9), 56.—This is an extensive paper giving details of the field, recycling project, and equipment and operations involved. The following extract from the foreword to the "Cotton Valley Section" explains the principles and reasons for the project:

"The benefits to be derived from recycling gas in reservoirs for the purpose of maintaining pressure and recovering distillate, and other hydrocarbons, may be summarized as follows: (1) pressure is maintained in the reservoirs, thereby reducing condensation of the hydrocarbons in the sand, which normally occurs when pressures are reduced. If this condensation should occur in the sand instead of above the ground, a considerable amount of fluid would become trapped in the sand and could never be recovered by ordinary producing methods. (2) By pressure maintenance, the waste of gas during production is eliminated, especially in areas where a gas market is not immediately available for all the gas produced. In this way the gas can be held in the reservoir until a market is available. (3) Where porosity and permeability are satisfactory, a wider spacing programme for the drilling of wells can be employed, thus eliminating the drilling of unnecessary wells which causes a serious economic burden on the industry. (4) Recycling results in a larger recovery of hydrocarbons/acre, thereby benefiting not only the operator and his investment, but also the land and royalty owner and the public generally because of the additional revenue accruing to the State in taxes.

"The above conclusions have been reached by the Louisiana Department of Minerals as a result of expert testimony given at the various hearings on this subject, and also as a result of observations made of the operation of plants that have already been constructed.

"Louisiana's first effort at recycling is in the Cotton Valley field, Webster Parish, where unitization has been completed on approximately 12,000 acres of gas-condensate producing land. In this field a large majority of the operators and royalty owners voluntarily pooled their interests. Unanimous approval was not obtained to the agreement, however, and the Department of Minerals was petitioned to issue an order which would make the plan 100% effective. Authority was granted to the Department to issue such orders after hearings by Act 157 of the 1940 legislature. After proper hearings such an order was issued, the plan became effective, and the recycling plant has been constructed and has recently begun operation." A. H. N.

870.* Core Analysis Presents Inclusive Formation Data. Anon. *Oil Wkly*, 31.3.41, **101** (4), 59.—Given proper supervision, core-recovery percentages will run sufficiently high to present necessary geological data and enable representative analyses to be made. In 1940, out of 54,789 ft. of hole-cores by a number of operators and appearing in the records of one laboratory firm, 40,718 ft. of core were recovered, or 74·7% recovery. These results were obtained with wire line, conventional and pressure-type core-carrels, in all diameters. The percentage of core recovery appears directly as a function of the service, attention, and interest which the cores received from the operator.

To yield best results in the core laboratory the cores should be of as large diameter as compatible with drilling practice at the well where they are secured. They should be subjected to a minimum of flushing with the mud stream, or, if cut "dry," should be drilled out at such a rate as to preserve within them the maximum percentages of oil, gas, and connate water, so as to present at the surface as close a reproduction of the reservoir *in situ* as possible. Lest any of the *in situ* characteristics be lost or altered, such cores should be examined and analysed promptly on being brought to the surface.

Analyses from adjacent core samples, a portion checked with adequate apparatus at the derrick and others packed with utmost care, including waxing or paraffin

coating to prevent evaporation, and then analysed at distant laboratories, show that the more representative and commercially significant values of all desired factors may be secured by immediate analysis. Such prompt determinations present a more representative picture of true reservoir conditions. Derrick-floor analyses, made promptly, also enable drilling changes to be made even within limits of comparatively thin strata while the bit is still in the formation being cored.

The use of the data is illustrated by actual core-graphs showing oil–gas and water–gas contact planes and other pertinent data. The work of many recent investigators is referred to and quoted to elucidate certain points. A. H. N.

871.* Factors Affecting the Use of Gravel in Oil Wells. K. E. Hill. *Oil Wkly*, 26.5.41, **101** (12), 13. *Paper Presented before American Petroleum Institute.*—The placing of a screen of gravel about the liner of a well is essentially a process designed to increase the permeability and porosity of the material adjacent to the well. By means of this process two fundamental benefits should result: (1) a decrease in the amount of sand migrating into the well-bore; (2) an increase in the production rate due to increasing the effective well diameter.

Therefore, a gravel screen should provide less resistance to flow, after equilibrium has been established, than would the liner and formation without the gravel. At the same time sand must be prevented from migrating into the well-bore. The work is discussed from the two viewpoints of the essential benefits outlined above.

A *résumé* of the various phases of the problem is given, and field, laboratory, and theoretical considerations lead to the following conclusions:

The use of gravel adjacent to the liners of oil-wells is intended to decrease sand production and increase the oil-production rate. Theoretically and practically both these purposes can be attained by the use of gravel which has a size ratio of 8 when compared to the diameter of the sand at the 10-percentile point on the cumulative screen analysis. However, due recognition must be given to the fundamental laws underlying the use of the frequency cumulative curves in the choice of gravel size for screening unconsolidated sand. The thickness of gravel should be at least five gravel-grain diameters.

Preliminary field results indicate that, after initial flush production, gravel-pack wells have higher production rates, better-sustained rates, and result in greater cumulative production than conventionally completed offset wells. This is a result of the ability to produce the gravel-pack wells at a greater percentage of their true potential capacity. Productivity indices which are lower for gravel-pack wells than for conventional wells are thought to be due to the use of mud instead of oils as the circulating medium.

Decreased sand production and an increased production rate should be obtained from the use of gravel in oil-wells, if a uniformly packed, closely sized gravel, with a gravel–sand size ratio of not more than 8 and a thickness of at least 5 gravel grain diameters, is placed in the well using oil as the circulating medium. A. H. N.

872.* Treatment of Oil-Sands with Surface-Active Chemicals. C. F. Bonnet. *Oil Wkly*, 26.5.41, **101** (12), 21. *Paper Presented before American Petroleum Institute.*—What is known about the flow of fluids in sand reservoir may be summarized thus:

Oil production from an oil-sand is proportional to the porosity, oil saturation, and the permeability of the sand. Oil-sands usually contain water, which is considered to surround the sand-grains so that the water lies between the oil in the pore-spaces and the sand-grain surfaces that form the walls of the pores. When water saturation exceeds 15%, the water interferes with the flow of oil and, if enough water saturation exists, water and oil will be produced together. When water saturation of the sand exceeds 80%, it is probable that the flow will be entirely water, and no significant volume of oil will be produced. The ratio of water production to oil and gas production is not necessarily the same as the ratio of water saturation to oil and gas saturation of a producing-sand section, but saturation and production tend to reach an equilibrium. Sands deposited in nature are seldom uniform, and usually consist of alternate layers that vary in porosity, permeability, and water and oil saturation.

Oil-sands may be treated with surface-active chemicals in order to reduce to a

minimum any harmful effects on oil production caused by excess water in the area surrounding a well-bore. In planning this treatment, consideration should be given to the physical characteristics of the sand and the effect of pressure differentials on the flow of the fluids in the sand.

Due to their unique effects on the interfacial relationships between water and sand and water and oil, surface-active chemicals may prove to be valuable tools for correcting abnormally poor production from oil-wells.

Composition and structure of surface-active agents greatly influence their effectiveness for various uses. Selection of effective surface-active chemicals requires correct analysis of conditions that prevail in practical use.

Field tests have been conducted under a variety of conditions. Results show that clear-cut benefits from the use of surface-active chemicals can be obtained only if the method of field application and the objectives of treatment are selected properly in relation to the importance of surface and mechanical forces in the reservoir.

Recognized limitations and benefits that can reasonably be expected from the use of surface-active chemicals in oil wells are discussed. A. H. N.

873.* Engine Heat Used Advantageously on Hydraulic-Pumped Lease. G. M. Wilson. *Oil Wkly*, 16.6.41, **102** (2), 17–18.—Usually wasted radiator-water heat, as well as heat obtained from the engine-exhaust pipes, is being utilized to good advantage by a company operating a number of hydraulic-pump-equipped wells in one of the California fields from two central locations.

The cost of the installation of a combined radiator-water and engine-exhaust-heat exchanger system has proved small compared with the savings being realized in boiler fuel, power-oil heating, and the elimination of extra handling of crude oil in lease-tanks.

The heat-exchange system consists of two independent parts: (1) a unit that derives heat from the hot engine-water from the two engines, and which heats all the oil, including power-oil, coming from the wells, and (2) a unit that absorbs heat from the exhausts from the two engines to heat the fluid produced by any single well that may be on special gauge, the heat aiding in dropping out the water in the gauge-tank. The two units are detailed and illustrated. A. H. N.

874.* Sand Tapping Improving Stripper Well Operations. F. R. Cozzens. *Oil Wkly*, 16.6.41, **102** (2), 20.—The water-control method is known as "sand-tapping," and differs radically from the old-timer's practice of drilling through the entire sand-body and shooting with as much nitroglycerine as the bore-face would hold. Such a practice generally brought the desired flow of oil, but in breaking up the low portions of sand it likewise brought in a deluge of salt water which flooded the well. Final results were usually determined by the amount of water and the operator's ability to exhaust it.

The modern method, instead, is to proceed with caution the moment the pay-sand is reached in a newly drilled well. From records of previous drillings in his district, the operator can estimate with considerable accuracy the thickness of the sand-body. After first measurements are taken, he cores the sand to an estimated depth of one-third its thickness. In most districts the average penetration is 4 or 5 ft. into the pay. In this penetration originates the reservoir which is prepared by lowering into the core three 4- by 16-in. cartridges of gelatin (about 30 lb.), 90% strength, straight N.G. grade. The charge is exploded by electric blasting cap and line, and it is seldom necessary to lift the casing. After the spoil has been stirred and removed by drill and bailer, the cavity is usually of sufficient size to hold 100–200 lb. of gelatin of the same grade and strength. About 100 lb. of sand or earth for anchor is poured down on this charge, and it is necessary to lift out the casing to prevent damage. This charge is also fired by electric cap and line. The results are good yield of oil and low salt-water production. A. H. N.

875.* Economic Selection of Oil-Field Equipment. Part 3. E. N. Kemler. *Oil Wkly*, 16.6.41, **102** (2), 34.—When bottom-hole pressure data are available from pumping or flowing tests the behaviour of the well will be found to follow the relation $Q = c(P_m - P)$, where Q is the production in brl./day, c (the productivity index factor)

is a constant for any well, P_m is the static reservoir pressure, and P is the pressure at the formation when the well is producing at a rate Q. If c and P_m are known, Q can be found for any value of P, or P can be found for any value of Q. If several values of Q and P are known, c can be calculated.

The method of calculating the well characteristic or productivity index factor from build-up data offers a simple and easy method, and does not require any production data to make the required analysis. The basis of arriving at this method is such as to make it as accurate as others. Further information on the limitations of each of these methods is necessary, but at present they offer the only basis for the prediction of well performance.

Both methods of determining c are given in detail in the body of the paper, and graphs from field tests are reproduced to illustrate the methods of calculations used.

A. H. N.

876.* Economic Selection of Oil-Field Equipment. Part 4. E. N. Kemler. *Oil Wkly*, 23.6.41, **102** (3), 35–42.—In this part of the paper horse-power requirements for the prime mover of a pumping well are studied. For simplicity, the oil is presumed to be free from gas. The lift is first calculated, and from that the formula for horse-power used is:

$$\text{H.P.} = \frac{350QSD}{33{,}000 \times 24 \times 60} = 0{\cdot}0000073SQD$$

where S = specific gravity; Q = brl./day (42 gal.); and D = net lift in feet. Charts are presented.

The theoretical horse-power requirements for pumping equipment are in general lower than would be normally expected, the overall efficiency of the pumping system being in many cases very low. The efficiency of the modern pumping units of all types is probably very high, and the efficiency from the reduction unit to the polished rod for well-designed equipment would be expected to be more than 90%. The largest loss will therefore result from sucker-rod friction, fluid friction, and pump friction. Of these the sucker-rod friction is undoubtedly the largest factor, and is, of course, subject to little if any control except in extreme conditions.

The lift efficiency (ratio of hydraulic horse-power to polished-rod horse-power) to be expected from sucker-rod type of pumping equipment is quite variable. Even under the best of operating conditions where producing considerable quantities of fluid it is doubtful if this efficiency can safely be taken as greater than 50%.

In the case where a well makes gas with the oil, the calculation of the required horse-power is quite difficult. In the case of a pumping well it is assumed that the free gas will be separated from the oil by the gas anchor, so that the only energy supplied by the gas will come from that gas which comes out of solution after the oil gets in the tubing string. Formulæ can be derived to give the theoretical amount of work which can be obtained from gas coming out of solution. The application of such formulæ is, however, very difficult, because the gas energy is normally used very inefficiently in the tubing string. Even when used at efficiencies of the order of 10–15% it will supply a considerable amount of energy for lifting purposes. A. H. N.

877.* Fault Shearing Off Oil Wells Presents Unusual Problems. G. M. Wilson. *Oil Wkly*, 30.6.41, **102** (4), 17.—Proving that the geologic forces and earth movements that accompany the forming of oil-bearing structures or entrapments are by no means static, an investigation into the cause of the collapse and shearing off of oil-well casings below the surface in a California oil-field has disclosed the existence of an active thrust fault, the over-riding portion of which is moving at the average rate of approximately 1–1½ in./yr. Between twenty-five and thirty pumping wells, within the past approximately 10 or 15 years, have been affected, damaged, and many even abandoned prematurely because of the relatively rapid movement of this thrust-fault.

The most serious damage to well casings appears to be confined primarily to wells that intersect the fault at depths shallower than 800 or 900 ft.

While several methods have been used in coping with this problem, the most successful form of relief used thus far consists of sinking a shaft around the casing of wells

the points of contact of which with the fault are not greater than approximately 200 ft. in depth. The shafts are dug by hand, and are carried down a short distance below the fault intersection, after which the damaged casing is removed. The shafts are lined with either 2 by 6-in. plank lagging or 72-in. welded stove-pipe, and then covered with a metal hood. The offset position of the shaft provides for a maximum amount of the movement of the moving upper portion of the thrust-fault before the casing would again be damaged or sheared off.

The new section of casing used to replace the sheared and bent section extending from just below the fault to the surface is not landed in a head, but is centred below the derrick floor by means of ¾-in. tie rods and turn-buckles anchored radially to the derrick substructure.

Details of the method as applied in typical wells are given. A. H. N.

878.* Practical Hints for Care of Multi-Cylinder Pumping Engines. F. Swindell. *Oil Wkly*, 30.6.41, **102** (4), 23.—Assuming that the pumping equipment originally purchased was properly selected and installed on a correctly designed foundation, a pumper need follow only a few simple rules materially to extend the economic life of multi-cylinder high-speed gas engines.

Generally speaking, these rules are: (1) an ample supply of good gas at proper pressure in the case of natural-gas operation, and a supply of good-quality gasoline where this fuel is used. (2) Good circulating water, or, if the water supply is bad, the proper treatment of it to avoid harmful effects. (3) Proper lubrication. (4) Proper attention to mechanical adjustment. (5) Proper engine speeds with regard to minimum speed fluctuation and to position on torque curve. (6) Proper maintenance of equipment that is being driven.

In enumerating these rules no attempt has been made to arrange them in the order of their importance, since it is doubtful if one takes precedence over the others. If these suggestions are placed in execution, it is safe to predict a satisfactory economic performance from any well-designed multi-cylinder engine. However, it must be remembered that unless the proper engine for the particular job to be performed is selected initially, it will be exceedingly difficult, if not entirely impossible, for the pumper to obtain satisfactory performance from the equipment. Each of the six items is discussed in detail.

Balancing wells are studied, and it is pointed out that there are wells that cannot be kept in proper balance, due to changing well conditions. Some wells produce slugs of gas that may continue for only a few minutes or they may last several hours. If the well has been balanced for the non-gaseous period, it will be out of balance while the well is producing gas. To meet this problem it is probably best to determine which of the two sets of conditions persist for the greater part of the well's daily pumping period, and balance for that condition. The well will then be out of balance for the other condition, and usually it will not be practical to try to change counterbalance as the well condition changes over short periods. However, the well condition as a whole will be better than had no attempt been made to balance for any part of the pumping period. A. H. N.

879.* Economic Selection of Oil-Field Equipment. Part 5. E. N. Kemler. *Oil Wkly*, 30.6.41, **102** (4), 28.—Of the items in equipment operation which are important, none is easier to control, and yet probably so neglected, as the question of counterbalancing. As a rough approximation it can be said that a well operating without proper counterbalance will impose in the equipment a peak torque which is at least twice the value with proper counterbalance, and for light loads may be several times this minimum value.

The determination of the proper counterbalance by calculation is for all practical purposes impossible. The calculation of the peak torque requires that the load-displacement or dynamometer card be known. The equation for such a card would be difficult to work with if it were known. Since no one has worked out a simple formula for such cases, the complete analytical treatment is obviously impossible. The next method would be to obtain a dynamometer card and from it work out the proper amount of counterbalance. Here again some difficulties arise. The work of determining the proper amount of counterbalance takes considerable time, and involves the time element of several days' waiting under normal conditions.

The maximum well load as it influences torque as given by the Slonneger formula is: $P = (Wo + Wr)\left(l + \frac{LN}{5400}\right)$, where P = polished rod load; Wo = weight of oil column on plunger = $0{\cdot}34\ Sd^2l$; Wr = weight of sucker rod = kl; L = length of stroke in inches; N = number of strokes/minute; l = well depth in feet; d = plunger diameter in inches; K = constant depending on sucker-rod string; S = specific gravity of fluid.

If the weights of the sucker rods are assumed to be counterbalanced, the net or unbalanced load P_u will be given by the formula:

$$P_u = (Wo + Wr)\left(l + \frac{LN}{5400}\right) - Wr$$

$$= Wo\left(l + \frac{LN}{5400}\right) + \frac{WrLN}{5400}.$$

$\frac{LN}{5400} = \frac{Q}{630ed^2}$, where Q = production in brl./day, e = volume efficiency of pump. $Wo = 0{\cdot}34Sd^2l$; $P_u = 0{\cdot}34Sd^2l\left(l + \frac{Q}{639ed^2} + \frac{KlQ}{630ed^2}\right)$. If e is assumed as being 70% and $S = 1{\cdot}0$, and, further, if $d = \left(\frac{KQ}{126}\right)^{\frac{1}{2}}$, the above equation will reduce to:

$$P_u = (0{\cdot}055\sqrt{KQ} + 0{\cdot}0075Q)l.$$

The peak torque will be given by

$$T = P_u \times \frac{L}{2} = (0{\cdot}055\sqrt{KQ} + 0{\cdot}00075Q)l\,\frac{L}{2}.$$

Charts are given and further approximations in the equations are made. The effects of the length of the stroke are clearly indicated with the aid of a chart. The remarks given have been inferred as applying to gear or chain-reduction units. They will apply equally well to a belt-driven countershaft-type rig-front. In this case the results of keeping the length of stroke down will be to give a lower belt-pull requirement. In general, a reduction in length of stroke will require an increase in speed, which will mean in turn an increase in belt speed (ft./min.) and a decrease in effective belt tension. For drives giving belt trouble a careful check should be made on the length of stroke, to see if conditions would permit a shortening of the stroke length.

A. H. N.

880.* Economic Selection of Oil-field Equipment. Part 6. E. N. Kemler. *Oil Wkly*, 7.7.41, **102** (5), 31.—To illustrate the method of selecting a most economical size of equipment to install in water-drive fields a specific example is discussed in detail. Two units are proposed after the characteristics of the field and wells are detailed and a comparative study of the two units is presented. Salt-water disposal is also considered in the problem.

When taking into account all the factors involved with equipment size it can be seen that a substantial saving can be effected by using the smaller equipment. It might appear that the larger unit has been unduly penalized by the higher operating and salt-water-disposal costs. The reverse is, however, probably true. This is because the operating costs will probably increase considerably owing to the production of large amounts of water, which is normally accompanied by considerable corrosion. The salt-water-disposal cost is variable and will depend on the manner and cost of disposal facilities. In some cases it may be only a fraction of a cent, whereas in case a deep-disposal well must be drilled, the cost, including its share of capital charges to repay the investment in the well and system, may be several cents/brl. While this example is not necessarily typical of all wells, it would be representative of some wells, and shows that considerable sums are saveable under many conditions.

A. H. N.

881.* Summary of Recent Opinions on Well-Spacing Problems. T. U. Ju and R. L. Huntington. *Oil Wkly*, 7.7.41, **102** (5), 36.—The main conclusion of the paper appears to be that whilst engineering principles of drainage are important in deciding on the well-spacing programme, economic considerations are often the controlling factors. The conclusions of the A.P.I. report on well-spacing are summarized as: (1) the rate of withdrawal materially affects the drainage area of the well. Given the former, engineers may, within reasonable limits, determine the latter. Under restricted withdrawal, regional reservoir drainage results and the drainage area of a well becomes indeterminate, reaching in some cases to remote points in the reservoir. Under such conditions effective drainage of a well becomes the size of uniform geometrical pattern which will insure adequate wells for reservoir drainage and rateable withdrawal. (2) The same or greater efficiency of recovery can be obtained by wider spacing at lower rates of flow/acre than by close spacing at excessive rates of flow. (3) Well density, within reasonable limits, is not a factor affecting ultimate recovery, when rateable withdrawal by owners of the oil in place is observed in a pool. Where the allocation does not recognize the basis of recoverable oil in place, uniform spacing units are necessary for the procuring of rateable withdrawals.

The strict economic phases of well-spacing have been discussed repeatedly by the Committee on Unnecessary and Unprofitable Drilling of the Independent Petroleum Association of America. In its latest report this group asserts that drilling excessive wells, which can be cured only by wider well-spacing, causes: (1) a large and unnecessary increase in development costs, which could be reduced by drilling of fewer wells/acre. (2) A steady decrease in per-well allowables, resulting in a long-delayed pay-out of investments. Curtailment of drilling rates would relieve this situation. (3) A curtailment in discovery and development of new reserves, occasioned by dissipation in drilling of unnecessary wells of the fund which would otherwise be available for that purpose. (4) Unnecessary consumption of steel and other materials needed in other industries during the current national defence emergency.

Whilst the majority of opinion is towards wide well-spacing, certain opinions are summarized which are against it, such as Clark's contention that the time factor in the rate of development sometimes dictates close spacing. A. H. N.

882.* Dual, Gathering, and Input Lines Mark Big Co-operative Cotton Valley Cycling System. E. Sterrett. *Oil Wkly*, 14.7.41, **102** (6), 61.—The agreement under which all sands lying below the base of the Travis Peak formation in the Cotton Valley field are unitized and are to be exploited by a committee from former individual producers in that area is sponsored by State conservation authorities and legalized by their action in declaring the return of lean gas to the sands a conservation necessity.

On this basis an operators' committee, representing either individually or by proxy every producer from the "D" and Bodcaw sands, planned the plant, the two gathering systems, and the straight-line top-of-structure input system, and worked out an equitable distribution of revenue whereby all operators would be compensated for wells already drilled, whether or not these were to be continued active either as gas sources or as input wells.

In listing the advantages to be derived from the accomplishment of unitization and cycling in the Cotton Valley field, the Louisiana Department of Conservation set up the following benefits:

The project will return to the State of Louisiana in taxes over $2,000,000 at the current rate of taxation from Bodcaw and "D" sands alone. It will increase ultimate distillate recovery by 50% by halting retrograde condensation in the formation, with accompanying increase of surface tension in the sands and resistance to all pressures. It will more than double the lift of the field as compared with former operating conditions. It will retard encroachment of edge and bottom water. It will prevent waste of gas in recovering distillate. It will eliminate drilling of unnecessary wells under offset requirements, effecting a saving estimated at $10,500,000. It will make possible economic recovery of gasoline and other hydrocarbon content from gas from Bodcaw and "D" sand-wells being blown to air under individual production. It will permit the recovery of stock-tank vapour loss at distillate wells, this loss being checked at from 15% to 20% of fluids produced under individual operation with usual lease-tank system. It will prevent the selling of dry gas at distress prices. It

will assist in maintaining a balanced oil and gas reserve within the sands at low relative cost.

The paper describes in detail, with many photographic illustrations of the various components, the gathering and input systems used. A. H. N.

883.* Modern Completion Practices. Anon. *Oil Wkly*, 14.7.41, **102** (6), 100.—A comprehensive review is given of recent methods used in completions of wells. The methods of obtaining and utilizing basic data to determine the exact depth and characteristics of producing sands—both in newly drilled and older wells—are detailed.

Multiple-zone completions and progressive completions up the hole are being expedited and assured through running drillable or acid-soluble alloy sections in the completion strings opposite known producing strata, with perforating, wall-scrapers, or nitro-shots to open the sheath behind such sections and permit exploitation of the pay. Where steel casing has been placed opposite an upper zone, improved cut-out tools are permitting economic removal.

In the proper conditioning of the producing sand-face it is now considered advisable to remove the mud-sheaths, and there have been many advancements in this direction. Included in these are acids for removing mud-sheaths, new casing-shoes that direct circulation fluid against the sand-face, jet-guns to scrub walls clear of mud, employment of scratchers or brushes mounted on the casing to break down the cake and permit its circulation out of the hole, and use of wall-scrapers and under-reamers to a larger extent. All these aid in procuring full productive capacity of the bore-hole exposure and increase yield of the wells.

There has been a growing use of gravel-packing as a means of protecting screens against clogging, crushing, or excessive cutting action. Gravel-packing is applicable either through perforated casing, in conventional manner, or by pre-packed liners.

Oil-base muds have been used, outstanding advantages of which are said to be: (1) minimize the possibility of impairing the natural-flow potentialities of the producing horizon such as that resulting from infiltration of water from water-base muds. (2) Permit smaller clearances for setting liners, since the mud-sheath has no appreciable thickness. (3) Eliminate the possibility of clogging the perforations of the liner with thick mud-sheath. (4) Facilitate the removal of the mud-sheath from the walls of the hole, for its mud-sheath has no appreciable strength. (5) Assist in drilling through formations such as heaving shale where water-wetting appears to be a source of difficulty. (6) Permit cores to be drilled and obtained without contamination from drilling water. A. H. N.

884.* Probability Theory Applied to Oil-Exploitation Ventures. Part 4. S. J. Pirson. *Petrol. Engr*, May 1941, **12** (8), 53.—This part of the Paper deals more particularly with producing than with unexplored properties. Principles are laid down and problems solved to illustrate the methods.

In general, the problem of applying the theory of probability to the business of discovering new fields has been reviewed, as well as the method of giving weight to possible hazards in the valuation of producing oil properties. An application of the theory of probability in order to calculate the odds against discovering oil by geochemical prospecting has also been made and the problem approached from various angles. The problem of the reliability of a discovered structure is also treated, and examples of calculations are given. A. H. N.

885.* Reconditioning Oil Wells in the Greater Seminole Area of Oklahoma. Part 1. J. I. Laudermilk. *Petrol. Engr*, May 1941, **12** (8), 114.—The main item discussed in reconditioning oil wells is shooting. As a preliminary step to shooting, the individual well should be studied on its own merits if the necessary data are available. In general, the factors affecting the shooting of the Upper Wilcox Sand in the Greater Seminole Area of Oklahoma include the items discussed below as to use and importance.

Date of initial completion is of value, inasmuch as this factor will materially affect the amount of oil yet to be recovered. The size of most oil-strings of casing in the Greater Seminole Area is ample to permit the use of any reasonable-size torpedo shell in placing the explosive at the desired depth. In some cases, however, this is

not true, for the size of the shell is restricted by the casing, and thus to some degree the amount of concentration of the shot possible is limited when torpedo shells are used to place the explosive, for a minimum annular space of ½ in. is required between the shell and the casing-string through which it is run.

The length of the casing-string is of even greater importance than the size, for the explosive must be placed at a sufficient depth below the casing-seat to prevent damage to the casing. The type and grade of casing used in the oil-well have a very definite influence on the possibility of the detonation of the explosive causing damage to the casing-string. The mechanics involved in the collapse of damage of casing due to shooting are not clearly understood, and become very involved when approached from a theoretical standpoint.

The total depth of the well is important for several reasons. Insufficient total depth will limit the size of shot that can be used without damaging the casing. In some instances, comparatively rare in the Greater Seminole Area, this feature will entirely eliminate the possibility of shooting the producing formation. The total depth of the well may also be used, together with the surface elevation and vertical correction, to determine the location of the shot in the formation so as to reduce the danger of shooting too close to the oil-water contact, and thus causing premature water encroachment or an increase in the existing water-oil ratio of production. Another use is for geologic correlation with other wells that have been similarly reconditioned in the past.

The importance of surface elevations in reconditioning work lies in the fact that variations in the ground surface are reflected in the depths necessary to reach a given geological marker or horizon in different wells.

Vertical and horizontal corrections for depths must be known and applied. Further, data on the producing formation itself, such as the top of the formation, the amount of penetration, and which portion is the best saturated part of the formation, should be known, in order to locate the shot and determine its size and concentration.

A. H. N.

886.* Estimation of Underground Reserves of Petroleum. Part 1. B. B. Bilibin, *Petrol. Engr*, May 1941, **12** (8), 141–143.—Methods of classifying oil-fields according to potentialities, and whether they are proved or unproved areas, are given, together with systems of map-colouring. The following methods are used to estimate reserves: (1) proved (A_1) and semi-proved (A_2) reserves: future yield of oil is determined by means of production-decline curves. (2) Probable (B) reserves: the quantity of oil to be recovered is estimated from production-decline curves based on the producing performance of wells in nearby similar oil-producing areas, or by the volumetric method. (3) Possible (C_1) and prospective (C_2) reserves are calculated by the volumetric method.

Part 1 of the paper deals only with types A_1 and A_2 reserves. The production-decline-curve method of estimating the future production of wells is based on well-performance data on individual wells or groups of wells producing oil from the areas under consideration. Production-decline curves are established from initial (30-day) production data, and the subsequent rate of decline of oil production projected into the future to the limit of the economic rate of yield. The initial yields and the rates of decline of oil production of wells depend on the characteristics of the oil-bearing formations, the manner in which the wells are operated, the rate of field development, and the spacing of the wells. Consequently, initial yields and rates of production decline are seldom the same for all wells in a group, even when the oil-producing formation is regular and uniform throughout an area.

As it may be necessary to calculate the quantity of oil remaining to a partly developed reservoir at any time during its exploitation, the initial yields of wells yet to be drilled and their rates of production decline are calculated by a special method based on the relationship between the initial yields of producing wells, their production-decline rates, the rate of development of the reservoir, and the natural characteristics of the oil-bearing formation. The method is known as the Method of Curves of Dependency and is based on actual well-production data, characteristics of the oil-bearing formations (reservoir pressure, permeability, etc.), and the field exploitation programme (rate of development, spacing of wells, etc.). Some discussion of these curves of dependency is included.

A. H. N.

887.* Functional Analysis of the Engineer's Place in the Petroleum Industry. Part 4. E. N. Kemler. *Petrol. Engr*, June 1941, **12** (9), 56.—The engineering functions of an oil-producing company are involved and technical in nature and are many in number. Because of this the supervision of the engineers must be by someone with technical training and ability. Maximum benefits cannot be obtained by placing them under someone without this training and ability. If proper attention be given to engineering matters, the engineering department can probably function to maximum advantage with a minimum of inter-departmental troubles if placed under the production superintendent. This will be true if engineering is made of sufficient importance so that the higher engineering positions offer opportunity and pay equal to equivalent operating positions. A careful setting out of the duties and responsibilities of the various departments is necessary to obtain best results. Furthermore, engineering departments should limit their activities to engineering functions, thereby keeping their number to a minimum, which will ultimately increase their general standing and importance and make possible a higher salary scale. A. H. N.

888.* Estimation of Underground Reserves of Petroleum. Part 2. B. B. Bilibin. *Petrol. Engr*, June 1941, **12** (9), 72.—The methods of constructing curves of the relationship between the initial yield of oil wells and other factors are detailed, with methods for calculating the probable rate of decline of an oil well.

For calculating oil reserves by the volumetric method, the formula used is: $S = Vdabc$, where S = total oil, in tons, that may be recovered from a pool; V = volume of the oil-bearing reservoir, area times thickness; d = density (sp. gr.) of the oil; a = coefficient of porosity; b = coefficient of saturation; c = coefficient of recovery.

By submitting actual figures (based on records of depleted reservoirs) for V, d, and a, which are known, the value of bc may be determined by using the following transformed form of the above equation:—

$$bc = \frac{S}{Vda}$$

Inasmuch as b and c cannot be calculated separately from field data, it is assumed in the calculation of oil reserves by the volumetric method that $bc = x$, the coefficient of utilization. The equation may then be written: $S = Vdax$.

When this equation is used in the calculation of reserves, each factor in the equation cannot be set down as having a definite value, but must be defined between maximum and minimum limits. Because of this fact, reserves estimates will then be calculated as being between certain limits, such as, say, 2–3 million tons, or as being a reserve of 30–40 million tons—a difference that may be considerable, but nevertheless within the limits of accuracy of the calculation.

The most difficult step in the calculation of underground oil reserves by the volumetric method is the determination of the coefficient of utilization (coefficient of saturation times the coefficient of recovery). Theoretical methods for arriving at a representative coefficient of utilization do not yield dependable results, and the best method is to base the coefficient on the production history of reservoirs that have been depleted of their recoverable oil. A coefficient of utilization so determined can be used with reasonable assurance of accuracy in the calculations of reserves in new areas.

In the calculation of prospective reserves it will be necessary to assume an average coefficient of utilization based on that determined for similar reservoirs. Under those conditions the coefficient of utilization should not be an arithmetic average value, but preferably one based on the most frequently repeated or most characteristic coefficients. Typical coefficients ranging from 0·9 to 0·2 are tabulated. A. H. N.

889.* Reconditioning Oil Wells in the Greater Seminole Area of Oklahoma. Part 2. J. J. Laudermilk. *Petrol. Engr*, June 1941, **12** (9), 86.—Further to the requirements detailed in Part 1, the following studies should be made before a reconditioning programme is applied: local subsurface conditions may be such that no inducement for reconditioning exists in certain areas. Due to localized geological features, it may be impossible for a given well to have any appreciable radius of drainage, or for there to be any considerable amount of physical reserves of oil in the vicinity of the

area drained by the well. Information concerning the probable size of the reservoir tapped by the well is very desirable, therefore, as is also knowledge of local subsurface conditions existing in the reservoir, which will affect the probable drainage radius of a given well.

The oil–water contact in the Upper Wilcox Sand in the immediate vicinity of the well in question is a factor of extreme importance. This knowledge allows the engineer to estimate the size of shot he can use without undue danger of increasing the rate of water encroachment.

Information on the total thickness of the Upper Wilcox Sand is very valuable, as it is indicative of local geological structures. It is also desirable in order that the efficiency of production and recovery with partial penetration can be estimated.

The production history has quite a distinct and important bearing on the possibilities and inducements for reconditioning work. If the decline in rate of production has been gradual, the present rate of production may be all that can reasonably be expected, in which case the shooting of the well would be merely a waste of money. If, however, abrupt declines have occurred in the production rate, the possibilities of the well in question should be thoroughly investigated. Even if no abrupt decline has occurred, however, it is advisable in many cases to study the comparative production histories of several wells in a given region, to determine whether the possibility of increasing the rate of production exists.

Having obtained all available information, a thorough study of the prior reconditioning work (if any) that has been done on the well should be made, as this will offer the best-known means of estimating the results of prospective work.

In summarizing the factors affecting the shooting of the Upper Wilcox Sand in the Greater Seminole Area of Oklahoma, it should be borne in mind that many minor factors other than those mentioned may be encountered occasionally in individual cases. The above-mentioned factors are of primary importance, however, and a thorough understanding and an appreciation of the importance of each should permit an intelligent approach to the problems of reconditioning oil-wells by shooting the Upper Wilcox Sand. It should especially be emphasized that as far as possible each well must be considered individually on its own merits.

The author then deals with results of shooting, explaining in detail the significance of the terms " initial change in production rate " and " sustained change in production rate."

A. H. N.

890.* Planning for Flexibility in Selecting Subsurface Lifting Equipment. P. F. Barnhart. *Petrol. Engr*, Midyear 1941, **12** (10), 25–28.—The Placedo field, Victoria County, Texas, is described, and main characteristics of the sand and the crude oil produced are given. Objective in this field is to progress from (1) flowing to (2) natural intermittent flow to (3) open gas-lift to (4) closed gas-lift operation with minimum equipment and labour. Practices involved are discussed.

In discussing the closed gas-lift operation it is concluded that input gas–fluid ratios vary from 225 to 800 cu. ft./brl., depending on well productivity and whether operating conditions are favourable or unfavourable. The calculated efficiency of lift, when determined, was approximately 22%, which may be considered satisfactory performance. The lift efficiency was calculated by determining the ft.-lb. of work performed in lifting a barrel of fluid, of known specific gravity, a given vertical distance, and dividing by the actual work developed during isothermal expansion of the gas used at given pressure in actually performing this work.

A. H. N.

891.* Factors Involved in Pumping Directionally Drilled Wells. W. A. Sawdon. *Petrol. Engr*, Midyear 1941, **12** (10), 46.—After a discussion of the wear and other difficulties encountered in slant-hole pumping the following conclusions are recorded: the lifting costs for pumping slant-drilled wells will probably be somewhat higher over a period of time than for well-drilled vertical wells. Not considering wear on rods and tubing, it is doubtful whether these costs should be much, if any, greater than with other wells, assuming the holes are drilled with careful control of direction and that full advantage is taken of equipment available for checking the performance during production. One company pumping slant-holes drilled during the last two years at Hungtington Beach is reported to have an exceptionally low lifting cost.

It would seem that the proportion of horizontal drift to vertical depth would have a direct bearing on the lifting costs; yet some of those wells with low costs extend more than 3000 ft. below the ocean at measured depths of approximately 5000 ft.

Any conclusions concerning the pumping of slant-holes must be based on the collective experience of many companies. The general opinion of field men in charge of pumping directionally drilled wells appears to be that such wells present no more problems than the average well and that subsurface conditions affect all wells to about the same degree. Tubing and rod wear is encountered in many wells of all classes, and might well be less in a slant-hole carefully drilled than in a vertical well put down with too much latitude for deviation from the vertical. The lubricating property of the crude oil and the effect of sand in wells making an appreciable amount of sand during production are, however, factors of greater importance in a slant-hole from the standpoint of wear on subsurface equipment. A. H. N.

892.* Economics of Multiple-Zone Completions. J. O. Lewis. *Petrol. Engr*, Midyear 1941, **12** (10), 52.—So far, four principles have been applied in the development of multi-zone fields: (1) to drill separate wells to each zone. (2) To exhaust one zone and then to re-complete into another. (3) To produce two or more zones together through the same well. (4) To produce two or more zones separately through the same well.

The important factors in exploiting a multi-zone field are costs and conservation. Obviously, it is to the interest of the producer to reduce his costs, but the public also has an interest in low costs, for experience teaches by many examples that any method resulting in a reduction of costs to a considerable portion of the industry leads to reductions in prices to the consumers. Furthermore, such reduced costs make commercially available petroleum supplies that would otherwise not be produced. Experience has shown that economics and conservation are inseparable and complementary.

Examples of multi-completions are given in detail. Although these examples are hypothetical, they illustrate the manner in which double completions operate to reduce costs, increase returns on investments, and make possible the development of leaner sands that might otherwise never be produced. It can therefore be viewed, when properly applied, as tending to conserve oil and gas by making available latent reserves. Moreover, conservation should not be narrowly viewed from the sole standpoint of oil and gas, for other national resources are involved in the recovery of oil and gas—such as man-hours of work, iron, and coal. The conservation of steel supplied at this moment appears more pressing than the conservation of oil and gas, and the industry has been asked to reduce its requirements. Double completions will save from 25% to 40% of pipe and other equipment.

Methods for multi-completion of wells in such manner that production can be carried beyond the flowing stage are a recent development, but so far they have been applied to only a few wells, although covering a wide range in conditions, including shallow-pumping wells in Kansas, gas-condensate wells 6500 ft. deep in Texas, and oil wells 9000 ft. deep in Louisiana. How far it will be practical to extend the use of these devices cannot be foretold at present. It may be expected that difficulties and objections will be encountered, but it is also probable that improvements in methods and devices will be made that will overcome many of the difficulties and objections. The limitations will have to be determined from experience.

A. H. N.

893.* High-Pressure Acidization of Cores. P. G. Shelley, J. B. Stone, and L. W. Colburn. *Petrol. Engr*, Midyear 1941, **12** (10), 60.—During the progress of this work approximately eighty cores from three sources were treated: (1) Niagaran dolomite from a quarry near Woodville, Sandusky County, Ohio; (2) oolitic Bedford limestone from a quarry near Bedford, Indiana; and (3) oolitic McCloskey limestone from producing wells in the Clay City and Noble poole of the Southern Illinois basin. These rocks were chosen for their comparative uniformity and availability. Analysis shows the Niagaran to be almost pure limestone.

Cores were treated at gauge pressures of three magnitudes: approximately atmospheric or zero, 1250, and 2500 lb./sq. in. on the downstream end of the core, with pressures from 100 to 200 lb./sq. in. higher on the upstream end to create a treating

differential. Data on only about half the cores tested are included in the tables, as difficulties with the apparatus and other factors negated the results obtained on the other half. Data on cores treated at atmospheric pressure are presented for comparison. Although all tests to date have been made at room temperature, provision for temperature control has been incorporated into the apparatus, and controlled temperature tests are contemplated.

The apparatus and technique employed are described in detail and the results are discussed. Perhaps the most important single conclusion that can be derived from a study of the data obtained in this work is that there is less tendency for the acid to channel at high pressures than at low pressures. This phenomenon is apparently due to the fact that at low pressures more of the carbon dioxide evolved by the reaction is present as a gas; consequently, many of the pores are blocked by Jamin action, with the result that the acid channels through the larger pores. In comparing either the pictures of cores or the tabulated data it should be remembered that the results obtained under high pressures probably more nearly approximate actual treating conditions, because at the bottom of a well the acid is always under a pressure greater than atmospheric. A. H. N.

894.* Well-Completion Methods. C. H. Rankin. *Petrol. Engr*, Midyear 1941, **12** (10), 78.—A description is given of the steps taken in completing a particular well in which practically all modern improved methods were employed. Thus is demonstrated the value of newer testing methods over those older methods of testing in which each show required a string of casing, and upper zones that did not appear to have potentialities were cemented-off. By testing in the newly developed manner, ten separate zones were tested individually and the potentialities of each fully explored.

Squeeze cementing, gun-perforating, zone testing, and the development of the devices that have made these methods practical have greatly increased the opportunities for the maximum utilization and development of new wells and the exploitation of undeveloped zones in older fields. A. H. N.

895.* Operating Data on Electrical Oil-Well Pumping. W. C. Lane. *Petrol. Engr*, Midyear 1941, **12** (10), 106.—The electrical pumping equipment used in one particular field is studied from the viewpoint of economics involved and performance data. It is the author's belief that in determining the cost of energy only real items of expense should be included. Not infrequently accounting systems involve practices that cause costs to be substantially higher than they really are, and as a result busy executives have erroneous notions concerning their costs. As a specific illustration a charge is often made for gas for which there is absolutely no market. In other cases the plant is charged a price higher than that received for the same product when it is sold to outsiders. Perhaps the most abused charge is that of overhead expense. It appears to be misleading and unfair to a plant to prorate the item of supervisory expense in proportion to the amount invested in plants, rather than in proportion to the amount of time and expense actually spent in supervising different projects controlled by an organization. In the data presented subsequently in this paper actual costs are used, unless estimates known to be approximately correct were used to eliminate much useless work.

Full details are included, and it appears that low cost energy for pumping and the reduction in field labour made possible by the use of electricity will prolong the profitable life of every well in this field served with electricity. A. H. N.

896.* Electrical Models as an Aid in Visualizing Flow in Condensate Reservoirs. W. Hurst. *Petrol. Engr*, Midyear 1941, **12** (10), 123.—Two methods are available to the engineer for model study: the electrolytic and potentiometric methods. The electrolytic method employs the travel of coloured ions in a medium under the influence of a voltage potential, and the coloured area swept out with time is representative of the area swept out by the dry gas in producing the wet gas of a condensate field. In the potentiometric method, however, the voltage distribution is obtained experimentally between input and output wells in the model, and from these

data the history of the movement of gas along streamlines is traced. A brief review is given of the two methods as used by different workers.

The author has employed both the electrolytic and potentiometric methods in electrical model analysis, and it is concluded that each method has its advantages and disadvantages. The electrolytic model is adaptable to showing a wave-front advance in a matter of a few hours, but the results cannot be accepted on a quantitative basis to give the characteristic curves for the instantaneous and overall ratios of wet to total gas production with time, which are important in the determination of the economic life for gas cycling. This is a limitation of the experiments that show a fading-out effect around the boundaries of the coloured ions in the model, and introduces a certain amount of ambiguity as to what does constitute the flooded tracts. This phenomenon occurs early in the test and gets worse with time, but whether it is diffusion, the individual mobility of ions, or even the combination of both, it is difficult to say. The potentiometric method offers a quantitative means for studying gas-cycling, as attested by a sensitivity of 1 mm. change in potential mapping, but, to offset this, the calculations take time in carrying out the necessary steps of the equation. The application, however, of a recent instrumental development of a mechanically linked planimeter and differentiator could reduce this time factor considerably, but, even so, the necessary calculations involved in this method would take a certain amount of time. Other comparisons of the two methods are given.

The study of gas-cycling in parallel sands is given in detail, and a worked-out example illustrates the calculation necessary. Three-dimensional flow is discussed.

It is the author's belief that the dry and wet gases are sharply defined in the formation without the diffusion of one gas into the other. This view is taken from the known fact that the diffusion of one gas into another is an extremely slow process, and the only way it is conceivable for the two gases in the formation to overlap is by a mixing process. Mixing can occur only by turbulent flow, however, and if D'Arcy's law applies, the flow must be streamline. From the knowledge of gas movement in a sand formation, it is concluded that the travel is usually slow enough to satisfy the validity of D'Arcy's law. A. H. N.

897.* Field Study of Valve Cups in Pumping Wells. R. C. Graham. *Petrol. Engr*, Midyear 1941, **12** (10), 138.—The results of observations on more than 600 pumping wells during three years are presented. The method of installing the cups and initial care taken to obviate damage to them are detailed. Results obtained by using improved designs and proper care gave approximately 60% reduction in cup jobs over a 3-year period. This substantial reduction of eighty cups jobs/month was immediately reflected in lower lifting costs and made it possible to continue to produce many wells and leases that would otherwise have been classified as non-commercial. The only additional fact found that has not been previously presented was that tight emulsions caused by fluid by-passing the harder and under-sized cups were greatly reduced and the oil–water separation was effected more readily.

It was found that distinct advantages result from proper cup usage. It is possible to increase oil reserves by eliminating premature abandonment of small producers where excessive cup-jobs or the added cost of high-priced pumps would dictate their abandonment. The elimination of frequent cup replacements permits a reduction in the number of workmen and the amount of equipment required to make the installations, thereby reducing direct expenditures. Finally, production cost while a well stands idle waiting on pulling equipment is reduced to a minimum, and in some cases offset drainage is eliminated.

Based on the results of the tests, the following recommendations are offered: (1) the travelling valve, barrel, and other bottom-hole equipment should be in first-class mechanical condition. (2) Cups should either be soaked in oil before running or allowed to set in the fluid at the bottom of the hole a sufficient length of time to absorb the oil. (3) Records of cup-runs should be available to rod crews so that previous runs may be studied and new installations made in cup sizes indicated by the records. As a general rule, plus 15-thousandths are best adapted to new or semi-new barrels, and plus 30-thousandths to old barrels. (4) Medium hardness cups give much greater service in wells having maximum depths of 2000 ft. The greatest drawback of medium-hardness cups is their tendency to turn when pulled

from the well. (5) Stitched cups and cups having reinforced shoulders are recommended. (6) No new design has yet been developed to cause any radical change in the standard make of cups. Deep bevels, inverted bevels, and copper wire between the plies show disadvantageous rather than beneficial results. A. H. N.

898.* Core Analysis Reliable Aid in Determination of Recoverable Oil. J. A. Lewis, W. L. Horner, and M. H. Stekoll. *Petrol. Engr*, Midyear 1941, **12** (10), 165.—The applicability of core-analysis data in estimating recoverable oil depends on several factors. One is that complete analysis of the cores must be made. Partial or incomplete analysis, coring and testing of intermittent sections of the formation are not conducive to accurate and reliable results. In addition, cores require careful analysis immediately on being brought to the surface. Transportation of cores, even in sealed containers, has been found to cause erroneous results with regard to the fluid content of the core. Sweating of the core against the sides of the container apparently occurs during transportation and results in measurements that are not directly comparable with those obtained at the well-site. Once the core analysis has been made, proper understanding, use, and interpretation of the data are necessary to translate the core-analysis results to accurate and reliable estimations of recoverable oil.

An estimation of recovery by water-drive (original bottom-hole pressure maintained) may be made directly from complete core-analysis measurements and calculations. Knowing the residual oil saturation in the cores, the shrinkage or formation volume factor as estimated or obtained from bottom-hole sample analysis, the connate water, and porosity from the core analysis, it is possible to calculate recovery by water-drive with accuracy. The method is detailed and illustrated by tables and charts.

The calculation of recovery by gas-expansion production is based on data similar to those for water-drive, with the major difference that the residual oil left in the formation under gas-expansion is almost invariably higher than that left in the formation after water-drive. Correlation between core-analysis measurements and the recovery obtainable in a gas-expansion field has resulted in accurate relationships being developed. Examples of the accuracy with which recovery by gas-expansion may be calculated is illustrated.

Once the field has been developed and the recovery by primary production obtained, complete information obtained from cores as applied to recoverable oil will indicate possibilities for secondary recovery operation. Secondary recovery operations in such circumstances may be carried out with a surety and an exactness of performance that will enable calculation on return of investment before the investment has been made. For instance, in a gas-expansion field the total recovery possible by artificial water-drive or by gas repressuring compared with that already obtained from the field will indicate the amount of recovery obtainable by either type of secondary recovery procedure. In water-drive fields the knowledge of the permeability profile, the recovery obtained, and the optimum yield will enable computations to be made with regard to the area drained by the water-drive. Determination may then be made with regard to the feasibility of work-overs. A. H. N.

899.* Petroleum Production Engineering Research Responsible for Tangible Advances in Practice. L. C. Uren. *Petrol. Engr*, Midyear 1941, **12** (10), 171.—Professor Uren reviews the major advances made in various fields of production engineering, and 83 references are appended to the paper, listing practically every paper of note published recently. The fields covered are fundamental properties of hydrocarbons and their phase relationships, reservoir conditions and performance, the testing of crude petroleum and formation samples, electrical logging and well surveying, well-spacing problems, studies on drilling fluids and oil-well cements, gravel packing and other well-completion and cleaning methods, flow of gas–liquid mixtures in vertical pipes and of dry gas displacing wet gas in condensate recovery, and researches on materials. The paper is, in fact, an extremely well-balanced *résumé*. A. H. N.

900.* Effectiveness of Gravel-Screens. B. H. Sage and W. N. Lacey. *Petrol. Tech.*, May 1941, A.I.M.M.E. Tech. Pub. No. 1325, 1–18.—Gravel-screens have been placed in water and oil wells for many years to increase the productivity and to decrease

the entrance of sand. The results of extensive experimental work on the effectiveness of gravel-screens are described. The factors considered in some detail include gravel-size and condition of packing, sand-size and size distribution, fluid velocity and viscosity, and the thickness and arrangement of gravel-screens. Good agreement was obtained between calculated values based on probability considerations and experimental results relating to the influence of the thickness of the gravel-screen. Graphs present data on the distribution of sand in the gravel-screens, the sand concentration in the oil leaving the screen, the influence of velocity on sand concentration, and other relationships.

The data presented are used to estimate the optimum diameter of gravel to be employed in a particular hypothetical situation, in which an attempt is made to allow for the influence of fluid velocity and viscosity, gas–oil ratio, formation pressure and temperature, size and condition of the gravel-packing, and the nature of the formation-sand. G. D. H.

901.* Mechanism of Fluid Displacement in Sands. S. E. Buckley and M. C. Leverett. *Petrol. Tech.*, May 1941, A.I.M.M.E. Tech. Pub. No. 1337, 1–10.—The production of oil is accomplished as a result of its displacement from the reservoir by either gas or water, and the amount of oil recovered is limited by the extent to which the displacing gas or water accumulates. Production by dissolved gas alone is fundamentally inefficient, and the oil recovery thereby is seriously limited. The displacing oil or gas does not behave purely as a piston ejecting oil, for in all cases the oil and displacing fluid flow together and simultaneously through the same pores. Hence displacement is never complete. The amount of oil displacement during the process depends on the relative ease with which the two fluids can move.

Equations are derived relating the various quantities and are applied to determine qualitatively the course of the displacement. The result is presented graphically.

The viscosities of the fluids, the initial fluid saturation, rates of flow, and capillary and gravitational effects are of varying importance, according to circumstances, and it is shown that the rate of displacement is of great importance in dealing with heterogeneous sands where high rates of flow may reduce the overall recovery.

G. D. H.

902.* Production under Effective Water-Drive as a Standard for Conservation Practice. E. DeGolyer. *Petrol. Tech.*, May 1941, A.I.M.M.E. Tech. Pub. No. 1340, 1–4.—The aim of good engineering practice and good conservation practice in oil production is to keep as much gas as possible in solution. Ideally the gas produced with the oil should be only that dissolved in the oil produced with it. This can best be done by producing a field as a water-drive field. Some degree of water-drive is believed to be present in most fields, but in the past most fields have been produced too rapidly to allow water-drive to be effective. Ultimate recovery by water-drive should be at least 50% greater than for fields produced by gas expansion. Wide spacing will permit fields of low-degree water-drive to be produced effectively as water-drive fields.

The disadvantages of effective water-drive are delayed return on investment and the necessity of grouping small tracts into larger units, but these are probably not insuperable. The standard should be applied to new pools and to the many older pools that have been reasonably well handled up to the present time. The Arkansas Oil and Gas Commission is operating under essentially the proposed standard, and the Railroad Commission of Texas recognizes the standard, even if it does not observe it. G. D. H.

903. Patents on Production. J. D. Ball. U.S.P. 2,241,439, 13.5.41. Appl. 4.5.39. Device for placing gravel in holes.

C. H. Barnes. U.S.P. 2,241,532, 13.5.41. Appl. 22.1.40. Bridging plug-slip means.

L. Spencer. U.S.P. 2,241,561, 13.5.41. Appl. 12.2.40. Bridging plug.

R. E. Millican. U.S.P. 2,241,643, 13.5.41. Appl. 1.4.39. Flow device for gas-lift operations.

C. S. Crickmer. U.S.P. 2,241,656, 13.5.41. Appl. 21.12.36. Means for flowing wells.

E. D. Bennett. U.S.P. 2,242,166, 13.5.41. Appl. 17.10.40. Apparatus for operating oil-wells having two producing horizons.

B. S. Lightfoot. U.S.P. 2,242,252, 20.5.41. Appl. 24.8.39. Pumping unit and power machine for deep wells.

O. Staerker. U.S.P. 2,242,551, 20.5.41. Appl. 17.1.38. Pumping apparatus with two working barrels.

G. D. Johnson. U.S.P. 2,243,099, 27.5.41. Appl. 16.8.38. Tool useful in recovering well-tubing, well-casing, etc.

E. W. Patterson. U.S.P. 2,243,117, 27.5.41. Appl. 19.11.35 and 6.1.39. Counterbalanced pumping unit.

E. E. Stevenson. U.S.P. 2,243,174, 27.5.41. Appl. 10.5.38. Method of and apparatus for heating and quenching sucker-rods.

C. S. Crickmer and H. C. Glitsch. U.S.P. 2,243,308, 27.5.41. Appl. 8.11.37. Flow-valve adapted to be connected into the side of a tubing-string.

M. De Groote and C. M. Blair, Jr. U.S.P. 2,243,329, 27.5.41. Appl. 27.6.40. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,243,330, 27.5.41. Appl. 27.6.40. Process for breaking petroleum emulsions.

H. V. Flemming and W. R. Barney. U.S.P. 2,243,598, 27.5.41. Appl. 14.10.38. Well-head fitting.

E. V. Foran. U.S.P. 2,244,684, 10.6.41. Appl. 5.7.39. Means for and method of flowing oil- and gas-wells in condensate fields.

R. Livergood. U.S.P. 2,244,714, 10.6.41. Appl. 5.12.38. Releasable sucker-rod connection.

G. W. Taylor, Sr. U.S.P. 2,244,812, 10.6.41. Appl. 4.10.39. Well-pump operating apparatus.

J. D. Dixon. U.S.P. 2,245,002, 10.6.41. Appl. 16.11.39. Means for controlling the flow of fluids in a well.

J. D. Dixon. U.S.P. 2,245,003, 10.6.41. Appl. 3.2.40. Means for lifting fluids from wells.

J. D. Dixon. U.S.P. 2,245,004, 10.6.41. Appl. 4.3.40. Well-fluid controlling device.

J. D. Dixon. U.S.P. 2,245,005, 10.6.41. Appl. 24.5.40. Means for controlling the flow of fluids under pressure.

J. D. Dixon. U.S.P. 2,245,006, 10.6.41. Appl. 9.11.40. System and apparatus for flowing wells.

J. D. Dixon. U.S.P. 2,245,007, 10.6.41. Appl. 14.12.40. Stuffing-box of duplex type.

J. D. Dixon. U.S.P. 2,245,008, 10.6.41. Appl. 30.12.40. Well-fluid flow controlling device.

J. D. Dixon. U.S.P. 2,245,009, 10.6.41. Appl. 6.2.41. Flow-valve.

J. D. Dixon. U.S.P. 2,245,010, 10.6.41. Appl. 10.5.41. System and apparatus for flowing wells.

C. A. Orleans. U.S.P. 2,245,114, 10.6.41. Appl. 6.1.40. Deep-well turbine pump.

J. M. Shimer. U.S.P. 2,245,117, 10.6.41. Appl. 21.4.39. Counterbalancing equipment for deep-well pumping apparatus.

W. E. Gilbert. U.S.P. 2,245,269, 10.6.41. Appl. 4.3.39. Sucker-rod fatigue-testing machine.

W. C. Richardson. U.S.P. 2,245,501, 10.6.41. Appl. 25.9.37. Reciprocating pump for deep-well pumping. A. H. N.

Transport and Storage.

904. Corrosion of Fuel-Tanks. Anon. *Aircr. Engng*, 1941, **XIII**, 173–174.—Recent investigations into the prevention of corrosion of aluminium and magnesium alloy fuel-tanks for aircraft have shown that not only are the composition and treatment of the metal used of importance, but also that the design of the tank is a factor to be taken into consideration.

The nature of chemical and heavy metal compounds accidentally introduced into the tank, either directly or through the medium of the fuel itself, largely determines, when water is also present, the extent and rate of tank corrosion. Cases of severe corrosion have also been attributed to the use of dissimilar metals in contact with the aluminium alloys used in tank construction.

Numerous methods of preventing tank corrosion are recommended. These include provision for thorough draining, the application of various chemical, anodic, or paint anti-corrosive coatings, and the use of inhibitive capsules which are placed in low spots of the tank where water is likely to collect.

It need scarcely be emphasized that all possible care should be taken to prevent the ingress to fuel tanks of contaminating bodies from any of the many likely sources. E. F. C.

905.* Method of Designing Cathodic Protection Installations. W. F. Rogers, *Petrol. Engr*, Jan. 1941, 42.—In considering cathodic protection systems two classes of pipe must be recognized: (*a*) well-coated pipe, (*b*) poorly coated or bare pipe.

In the case of (*a*) it is generally accepted that a potential of 0·8 v. will afford protection. This is normally a voltage increase of 0·25 v. in excess of the unprotected potential. Few corrosive soils have a resistance of more than 2000 ohm-cm., and it is calculated that a potential of 0·25 v. will result in a current flow of 0·008 amp./sq.ft. It has been shown that this current flow will give 82·5% protection, and this is the minimum that will be obtained if an impressed voltage of 0·25 v. is maintained on the coated pipe.

The paper shows how it is possible to determine the current source spacing to give protection to the pipe.

In the case of (*b*) design calculations are equally possible. Here current-density values, rather than pipe-soil potentials, are the criterion. The data show that 0·004 amp./sq. ft. will give 75% protection to bare pipe in corrosive soils.

The ground bed exercises a very important place in cathodic-protection schemes, and in general must fill two functions satisfactorily: (1) to dissipate the current properly, without too frequent replacement of the ground-bed material, (2) to have a low electrical resistance.

Junk-steel pipe is the most common form of ground-bed material. The resistance of the bed must be kept as low as possible in order to reduce current costs, and this involves the determining of the best arrangement for the junk-pipe. It is shown that there is an optimum depth for burying the pipe, but varying the spacing is without great effect.

It is necessary that the soil resistivity be less than 1000 ohm-cm. in order that a maximum resistance of the ground-bed of 0·1 ohm can be obtained. If the soil resistance is greater than this it is essential to salt the ground-bed. This is carried out with calcium chloride, which is both highly ionized and very hygroscopic. D. L. S.

906.* Prevention of Corrosion of Steel Pipe-Lines by Oil-Well Brines. W. Stericker. *Oil Gas J.*, 27.2.41, **39** (42), 72.—Laboratory experiments had shown the efficiency of sodium silicate as an inhibitor in the corrosion of steel pipes carrying oil-well brines. The preventive action is due to the formation of a protective coating on the inside of the pipes, but the concentration needed in laboratory tests was too high to be economical. However, in actual practice the author has used a much lower concentration—40 parts per million of soluble silica—with success. Over a period of 2½ years the number of leaks in such a pipe system have been reduced by 50% and the cost of laying an entirely new pipe system, as was originally intended, has been avoided. Further work is continuing on this method of treatment. H. C.

907.* Develop Interior Coatings for Aviation Fuel-Drums. M. G. Van Voorhis. *Nat. Petrol. News*, 30.4.41, **33** (18), R.130.—The increased use of steel drums for the transportation and storage of aviation gasoline has stimulated the development of anti-corrosion linings for the drums. Galvanizing is not a satisfactory solution to the problem, owing to the formation of loose zinc oxide. Lead coating is said to be more satisfactory. Zinc coatings have been improved by the use, after galvanizing, of solutions of chemicals which produce, on the zinc, coatings somewhat similar to those of anodized aluminium. Varnishes and lacquers are being improved to eliminate the present shortcomings of the materials of those classes now in use. A promising development consists of the addition to the gasoline of lecithin, a soya-bean derivative. H. G.

Gas.

908. First Commercial Liquefaction Plant in Full-Scale Operation. P. A. Condit and W. F. Burgess, *Oil Gas J.*, 1941, **39** (45), 46–48.—A description of the first plant for liquefaction and storage of natural gas for distribution to industrial and domestic users, recently erected for the E. Ohio Gas Co.

Three 57-ft.-diameter Hortonspheres are used, holding 150 million cu. ft. of liquefied gas under a pressure of 25 lb. per sq. in.

The stages of the process are as follows: natural gas—two-stage compression to 615 lb.; removal of moisture and liquid CO_2; chilled (by NH_3) to — 126° F.; removal of liquid N_2; chilled (by ethylene) to — 139° F. (now mostly liquid); pressure released to about 60 lb. at — 218° F., recycle gas removed and liquid reduced to 25 lb. at about — 248° F., then transferred to Hortonspheres. Gas accumulation in the spheres is continuously removed and returned to a flash-gas compressor for re-treatment.

Details of the specialized compressor equipment and of the highly important balancing operations are given. A complete flow-sheet and photographs of the plant are also shown. C. G. G.

909. Natural Gasoline Yields Numerous By-Products. F. H. Dotterweich. *Oil Gas J.*, 24.4.41, **39** (50), 39.—Natural gas consists of the hydrocarbons CH_4–C_7H_{16} and the non-hydrocarbons CO_2, He, N, and H_2S; it is divided into three fractions: dry gas (CH_4–C_2H_6); liquefied (bottle) gas (C_3H_8–C_4H_{10}), and natural gasoline. Except for CO_2, the non-hydrocarbon content is low; H_2S may be removed, as it is corrosive, and marketed for agricultural use.

For the production of raw materials for syntheses, the natural-gas paraffins are rendered reactive by four methods: decomposition, oxidation, halogenation, and nitration. By the first method olefins and hydrogen are obtained for use in the production of plastics, synthetic rubber, motor fuel, explosives, dyestuffs, and for use in hydrogenation. By the second, alcohols, aldehydes, ketones, and ethers are obtained—the raw materials of many modern products. The third method yields parent products of T.E.L., vinyl chloride, and acetate for plastics and sodium polysulphides for the manufacture of thykol. Nitration is the process most recently introduced, and yields nitro-compounds used as organic reagents and in the manufacture of explosives.

Dehydrogenation and polymerization of natural gas leads to the production of high anti-knock fuels such as *neo*hexane, which has O.N. 94 and a high lead susceptibility, making possible the production of 115 O.N. fuels. T. T. D.

910. Annealing Atmospheres from the Combustion Products of Gaseous Fuels. A. G. Hotchkiss. *Industr. Engng Chem.*, 1941, **33**, 32.—The use and cost of natural gas, butane, and propane are compared with that of coke-oven gas and dissociated ammonia for the production of inert annealing atmospheres. The composition of the atmospheres produced from the combustion of these gases at various air–fuel ratios is given. The design of apparatus for the control of combustion is discussed and methods of purification for the removal of H_2O, H_2S, SO_2, and CO_2 are reviewed.
J. W. H.

911. Protective Atmospheres for Hardening Steel. J. R. Gier. *Industr. Engng Chem.*, 1941, **33**, 38.—The composition of a protective atmosphere for hardening steel is the following function of the carbon contents of the steel (*c*) $= k_2\frac{(CO)^2}{(CO_2)}$, where *k* is the equilibrium constant in the reaction $2CO = CO_2 + C$. The production of this type of controlled atmosphere is effected by the endothermic combustion of air and hydrocarbon fuel in an electrically heated catalyst furnace. In this process the hydrocarbons are almost completely decomposed into carbon and hydrogen (an endothermic reaction) and the carbon combines with oxygen to form CO (an exothermic reaction). There is an energy deficiency between these two reactions which is supplied by the electric heater.
J. W. H.

912. City Gas for Special Atmospheres. C. R. Cline and C. G. Segeler. *Industr. Engng Chem.*, 1941, **33**, 46.—A composition of gases suitable for metal annealing without scaling or decarburizing, bright hardening, clean heat treatments, carburizing, fire protection, and purging of combustible gases from storage vessels, is presented. The types of equipment required to produce and purify these special atmospheres are discussed. Original data are presented showing the variation in flue-gas composition with combustion air, fuel-gas composition, and combustion wall and flue-gas temperatures. From these data the composition of flue products resulting from the burning of a fuel gas of known analysis with a predetermined air–gas ratio can be accurately estimated.
J. W. H.

913. Gas Carburizing by the Hypercarb Process. W. A. Darrah. *Industr. Engng Chem.*, 1941, **33**, 54.—The hypercarb process supplies a controlled high-carbon case on steel articles by heating in a controlled atmosphere of hydrocarbons and carbon monoxides at 1700° F. The carburizing gas initially contains 70–80% methane and is produced by cracking of natural gas. The gas is recirculated and is stated to become activated during this process. No analyses of the circulating gas are given. Steel articles treated by this process are free from carbon scale and no cleaning is necessary.
J. W. H.

Cracking.

914.* Kinetics and Chemistry of Cracking of Hydrocarbons. Dr. R. Rosen. *Oil Gas J.*, Part 1, 13.2.41, **39** (40), 49–50; Part 2, 20.2.41, **39** (41), 45–46.—Two papers in which the author presents a digest of a series of articles by M. D. Tilicheev of the U.S.S.R. and others dealing with the subject of the kinetics and chemistry of cracking of hydrocarbons. An attempt is made to unify the available data for the various hydrocarbon classes and to present it in tabular form. Most of the studies discussed involve the use of a static method in an iron apparatus, and the sum total of the reactions involved in cracking is dealt with, and not the separate simultaneously occurring reactions of decomposition, polymerization, isomerization, etc. The tables of data consist mainly of cracking-velocity constants at various temperatures for paraffins, olefins, di-olefins, aromatics, naphthenes, and cyclic unsaturated compounds. Conclusions are reached as to the order of the cracking reactions and the variations in cracking-velocity constant with varying molecular weight, whilst additional data included are comparative thermal stabilities of paraffins and olefins and the effect of pressure on polymerization velocity constants. Finally there is a discussion on the relative coking tendencies of the various classes of hydrocarbons, and a comparison is made of the kinetics of " carboid " formation, carboids being defined

as substance insoluble in hot benzene. A general outline is given of the chemistry of carboid formation.

The available data, foreign and American, are amplified by interpolation, whilst tentative assumptions and various corrections have been made. Accordingly the data must be regarded as correct only in the first approximation, and are subject to revision as new experimental material is accumulated. J. C.

915.* Control Point Computed for Cracking Furnaces. R. E. Summers. *Nat. Petrol. News*, 30.4.41, **33** (18), R.143.—In controlling the temperature of oil issuing from an oil-heater it is often desirable to locate the control point some distance ahead of the outlet. Temperatures may change by a greater amount or earlier than at the outlet, but if held within narrow limits the control can be made to give uniformity at the outlet. A mathematical method for computing the point in a cracking furnace where average conditions obtain is presented. H. G.

916. Patents on Cracking. A. C. Jessup. E.P. 536,891, 30.5.41. Appl. 30.11.39. A catalyst for the single-stage or closed-vessel process for cracking heavy oils in the liquid phase. It consists of metallic iron and copper. The process may be carried out in a copper vessel, finely divided iron being added. An atmosphere of hydrogen at 10–20 atmos. is maintained in the reaction chamber. About 70% of the sulphur present is obtained as metallic sulphide. The catalyst enables the cracking to be performed at a comparatively low temperature.

P. Mather. U.S.P. 2,242,255, 20.5.41. Appl. 20.10.38. Cracking of hydrocarbons. The oil is heated to cracking temperature under raised pressure. The product is flash-distilled. The vapours are separated, fractionated, and condensed, and the residual oil is subjected to a second flash-distillation, without further cracking. The vapours evolved are condensed and supplied to the cracking step. The residue from the second flash-distillation is mixed with small amounts of a light distillate and heated to a point where the light distillate is vaporized and mild cracking of the residue occurs. These products are removed from the heated zone before deleterious secondary cracking reactions occur, and are passed to a low-pressure distillation zone, where they are reduced to a semi-solid residue. The vapours evolved are condensed.

C. L. Thomas and H. S. Bloch. U.S.P. 2,242,553, 20.5.41. Appl. 30.11.38. Cracking of hydrocarbons. The oil is contacted at cracking temperature with a calcined precipitated silica containing precipitated alumina and thoria.

J. D. Seguy. U.S.P. 2,243,291, 27.5.41. Appl. 31.8.39. The process comprises introducing cracked vapours, and charging oil for the process to a separating and fractionating zone. A product of end-boiling point 600–650° F. is separated, and is further fractionated, giving a light gasoline of high anti-knock value, a heavy gasoline of low anti-knock value, and a heavier reflux condensate. The latter is subjected to a mild vapour-phase cracking (10% decomposition per pass through cracking zone). The resultant products are reintroduced into the separating and fractionating zone. The heavy residue from the fractionating is subjected to a mixed-phase cracking. The vaporous products are introduced into the separating and fractionating zone. The heavy gasoline fraction is cracked under conditions giving the greatest anti-knock value in the product, which is passed to the second fractionating column.

B. L. Kramer. U.S.P. 2,243,315, 27.5.41. Appl. 30.12.37. The oil is cracked under pressure, the resultant products are separated under pressure, and the vaporous phase is fractionated, giving a light distillate and normally gaseous hydrocarbons. The unvaporized oil from the first separation is flash-distilled by pressure reduction, and the vapours are fractionated to give a highly olefinic distillate, containing much gasoline-range oil. The gaseous hydrocarbons formed in the first cracking are scrubbed with an absorber oil consisting essentially of the highly olefinic distillate from the second cracking, to absorb gaseous olefines. H. B. M.

Hydrogenation.

917.* Hydrogenation of Coal—Insurance for the Oil and Automotive Industries. W. L. Nelson. *Oil Gas J.*, 8.5.41, **39** (52), 55.—A general article on the status of the coal-hydrogenation process in the U.S.A. It is suggested that it may become expedient to utilize a combination raw stock of coal and oil in order to stabilize the petroleum industry as a whole and to conserve reserves in face of the growing demands of the motor-transport and aircraft industries. The economics of hydrogenation is discussed in relation to known costs of operation in Great Britain and in Germany. The ease of eliminating S, N, and O from the products is emphasized and also the fact that present commercial practice is a compromise between excessive hydrogenation giving low-octane material and excessive decomposition giving high-octane material but large amounts of coke. The influential factors in the process are stated to be: (1) the vehicle or solvent, (2) the use of agitation, (3) the use of a catalyst, (4) suitable temperatures and pressures; and the importance of these factors is exemplified in short accounts of a British plant of the Low-Temperature Carbonization, Ltd., and an experimental plant of the U.S. Bureau of Mines. A brief survey of the enormous American coal reserves is followed by a description of a method for correlating oil yield against types of coal by means of petrographic examination for the various constituents. The article concludes with some summarized figures of the yields of the various oil-cuts. J. C.

918. Patents on Hydrogenation. Phillips Petroleum Co. E.P. 535,813, 23.4.41. Appl. 11.8.39. Conversion of simple paraffins into saturated hydrocarbons of higher molecular weight by dehydrogenating the paraffin hydrocarbons, thereby forming free hydrocarbons and polymerizable olefins. The latter are subjected to polymerization, and a substantial portion is converted into olefinic polymers of higher molecular weight. The hydrocarbons of lower and higher molecular weight are then separated and those of higher molecular weight passed into contact with a depolymerizing catalyst. The products of depolymerization are passed to a previous separating step, and a portion of the hydrocarbons of lower molecular weight hydrogenated with hydrogen produced in the hydrogenating step. H. B. M.

P. S. Danner. U.S.P. 2,241,393, 13.5.41. Appl. 14.3.38. A heated mixture of naphthenes and olefines is passed over a catalyst in a hydrogenation–dehydrogenation zone. Naphthenes are dehydrogenated to aromatics and olefines are hydrogenated to paraffins. The vapours are quenched by direct contact with a high-boiling organic selective solvent for cyclic hydrocarbons, to stop side reactions and to separate paraffins from cyclic hydrocarbons. H. B. M.

Polymerization.

919.* Isomerization of Feed Stocks Charged to Alkylation Units. L. J. Coulthurst. *Oil Gas J.*, 23.1.41, **39** (37), 37.—The alkylation process, by which a direct combination of butylenes (C_4H_8) with *iso*butane (C_4H_{10}) produces *iso*paraffins, including *iso*-octane, is stated to be an efficient and remunerative method of obtaining high-octane blending stock, to form the main ingredient of 100-octane aviation gasoline. Most refiners have available an ample supply of butane, but not of *iso*butane, and it is now commercially practicable to convert the normal into the *iso*-compound. This conclusion is based on the work of Moldavskii and Nizovkina, *Nat. Petrol. News*, Vol. 32, pp. R.422–428, 27th Nov., 1940. The isomerization process described is available generally for the conversion of straight-chain paraffins into branch-chained *iso*paraffins, but only laboratory results are quoted. In liquid-phase operation a maximum of 74% of *n*-butane may be converted into *iso*butane by isomerization at 158° F. using a mixed catalyst, $CuSO_4.2HCl + AlCl_3$. In vapour-phase operation at a temperature range 158–356° F., $AlCl_3$ alone and gaseous HCl was used as catalyst and a maximum of 67·3% conversion was obtained. J. C.

920. Patents on Polymerization and Alkylation. Standard Oil Development Co. E.P. 536,813, 28.5.41. Appl. 23.10.39. Production of gasolines by a combination of the processes of polymerization and alkylation, from gaseous or lower-boiling

olefins and *iso*paraffins. A mixture containing olefins and *iso*paraffins is fed into an activator, where polymerization of the olefins occurs. The resulting hydrocarbon product, preferably fortified by addition of *iso*paraffins, is fed into the same activator at higher concentration, to cause reaction between the *iso*paraffins and the olefins and polymers. Spent activating agent from the alkylation system is fed into the polymerization system, whilst spent activator from the latter is withdrawn for regeneration. Higher-boiling hydrocarbons, predominantly saturated, are recovered from the alkylation process. The product so obtained appears to possess a higher octane number than is obtainable by reaction between *iso*paraffins and unpolymerized olefins. Careful control of polymerization is unnecessary, as the higher polymers are as suitable as the dimer as feed-stock for the alkylation unit.

G. Roberts, Jr., and G. W. Robinson. U.S.P. 2,241,716, 13.5.41. Appl. 15.6.37. The preparation of liquid hydrocarbons from gaseous by treating the latter at high temperature and pressure. The improvement comprises passing the gaseous products of conversion through a liquid absorbent under pressure, so that convertible constituents are recovered by solution. The scrubbing solvent is indirectly cooled by a fluid from an extraneous source. The scrubbed gases are extracted, and their expansion is utilized in pumping the cooling fluid.

G. Roberts, Jr., and G. W. Robinson. U.S.P. 2,241,717, 13.5.41. Appl. 15.6.37. A stream of gaseous hydrocarbons is heated under pressure, thereby forming liquid hydrocarbons. The stream is separated under pressure into a liquid fraction containing the relatively high-boiling normally gaseous hydrocarbons, and a gaseous fraction predominating in the lower-boiling gaseous constituents. The gaseous fraction is passed to a separatory zone, where a fraction predominating in hydrogen and methane is removed. The liquefied, normally gaseous hydrocarbons are withdrawn from the separatory zone, and all or part of them are added to the stream undergoing conversion. The liquid fraction from the conversion is freed of normally gaseous hydrocarbons under reduced pressure. The gaseous fraction predominating in hydrogen and methane from the separatory zone is passed at pressure through a scrubbing zone containing a liquid absorbent medium, which dissolves convertible constituents of the gas. The enriched solvent is freed of the convertible hydrocarbons, which are introduced into the separatory zone. A stream of normally gaseous hydrocarbons is introduced into the system from an extraneous source. The scrubbed gases are expanded, the expansion being utilized to compress the stream of gaseous hydrocarbons entering the system. The compressed stream is cooled, and the liquid fraction so obtained is added to the separatory zone to assist in the separation therein.

M. M. Holm. U.S.P. 2,245,038, 27.5.41. Appl. 14.10.40. A process for the alkylation of *iso*paraffins with olefins, using an acid alkylation catalyst. Two zones of reaction in series are used. The concentration of *iso*paraffin is kept at at least 50% by liquid volume in the first zone, where a high degree of dispersion of the catalyst is maintained. In the second zone the mixture is subject to a force tending to separate catalyst and hydrocarbons, so that part of the reaction mixture becomes richer in catalyst, part poorer. A portion of the part rich in catalyst is recycled to the first reacting zone, and a part poor in catalyst passes to a separating zone, where the acid catalyst is removed. H. B. M.

Synthetic Products.

921.* Cold Resistance of Synthetic Rubber. W. J. McCortney and J. V. Hendrick. *Industr. Engng Chem.*, 1941, **33** (5), 579.—An accurate method for determining the deformation resistance of synthetic rubbers at $-40°$ C. has been developed. The results show that small variations in compounding greatly affect the stiffening characteristics at low temperatures. J. W. H.

922.* Raw Material Plentiful for Synthetic Rubber. I. E. Lightbown and J. E. Britton, Jr. *Oil Gas J.*, 17.4.41, **39** (49), 174.—The first synthetic rubber was made from *iso*prene, which was originally obtained from turpentine. Later (1900) different

and more readily obtainable olefins were studied, and thus Buna—butadiene polymerized in presence of sodium—was developed. At about this time it was realized that the goal to be reached was the production of a synthetic material substantially better in some respects than the natural rubber.

In 1926 Duprene or neoprene was produced from chloroprene, whilst in Germany "Buna S," made from butadiene and styrene, and "Perbunan," made from butadiene and acrylonitrile, were developed. These polymers were found to be little affected by oils, and their production on a commercial scale fundamentally affected the construction of rubber hoses used for conveying materials of petroleum origin.

Besides its lack of oil resistance, natural rubber is also prone to deterioration by oxidation, due to the number of double bonds it contains. These double bonds are by no means all satisfied by the process of vulcanization.

The next step in the production of a suitable synthetic was therefore the development of a more saturated rubber, and the material known as "butyl rubber," which had only about one-hundredth the unsaturation of the natural product, was evolved. This used simple olefins as the starting material, only enough diolefines being included to give sufficient unsaturation to the finished rubber for the necessary vulcanization.

At present about 97% of the U.S.A. requirements of rubber are imported from the Far East. If this supply were interrupted, a tremendous expansion of the synthetic industry would be necessary. Fortunately all the basic materials involved are potential petroleum derivatives. Since on a weight basis the U.S.A. annual import of crude rubber is only about one-third of 1% of the crude oil produced, there would appear to be no need for concern over the question of raw material supply for the synthetic rubber industry. D. L. S.

923. Patents on Synthetic Products. A. C. Jessup. E.P. 536,734, 26.5.41. Appl. 30.11.39. Production of *iso*butylene by heating to 300–500° F. either or both straight-chain chlorides of butane in the presence of aluminium chloride. The butylene chloride is formed from butylene and HCl.

M. De Groote and C. M. Blair, Jr. U.S.P. 2,243,329, 27.5.41. Appl. 27.6.40. A process for breaking petroleum emulsions. The demulsifier is for breaking the water-in-oil type of emulsion. It consists of a basic type acylated polyamine of the following formula :—

$$\begin{matrix} Z \\ Z \end{matrix}\!\!>\!NC_nH_{2n}(C_nH_{2n}NZ)_x - N\!<\!\!\begin{matrix} Z \\ Z \end{matrix}$$

n = number from 2 to 10, x = number from 1 to 10, Z is either H, RCO, R′CO, or D, in which RCO represents an acyl radical derived from a higher-weight carboxy-acid; R′CO is an acyl radical derived from a carboxy-acid having 6 carbon atoms or less; D is alkyl, hydroxyalkyl, aminoalkyl, or acyloxyalkylene, in which instance the acyl group is a member of the class consisting of RCO and R′CO. The polyamine is further characterized by the fact that there must be present a member of the class consisting of (*a*) acyloxyalkylene radical, in which the acyl group is RCO, and (*b*) joint occurrence of an amido radical in which the acyl group is RCO and a hydroxyalkyl radical.

M. De Groote and B. Keiser. U.S.P. 2,243,330, 27.5.41. Appl. 27.5.40. Process for breaking petroleum emulsions of the water-in-oil type. The demulsifier consists of a water-soluble polyglycol ether derived by reacting an alkylene oxide with an alkylated monocyclic monohydric, water-insoluble phenol characterized by the fact that the nuclear carbon-atom-alkyl linkage involves a tertiary carbon atom of the alkyl group, and by the fact that the longest alkyl radical carbon atom chain, beginning with the tertiary atom as unity, contains 3 to 5 carbon atoms. H. B. M.

Refining and Refinery Plant.

924.* Stress-Relieving Welded Pressure Vessels in the Field. E. S. Robb. *Refiner*, July 1941, **20** (7), 251–257.—Stress-relieving of existing welded vessels may be necessary, or at least desirable, because of, first, previous operating conditions which set

up internal strains in the metal due to sudden temperature changes; second, extensive repairs to welded seams or nozzle connections; third, additional heavy welding occasioned by the addition of new nozzles, manways, or reinforcing pads, and fourth, possible salvaging by major repairs or revisions that can be done in the field.

The necessity or desirability for stress-relieving is a question best answered by the local and manufacturers' engineers. The fact that in many cases stress-relieving may be done without the vessels being moved from their foundations may be the deciding factor, and is therefore of practical and economical importance. Not only is there a large saving of direct costs with this method, but several weeks of operating time may be saved, and this is often the most important consideration.

The stress-relieving temperature generally used for low-carbon steel is between 1100° F. and 1200° F. The soaking time required at this temperature is 1 hr./in. of wall thickness as a minimum. Since extra soaking time may be desirable, a more conservative rule is to add the thickness of the heaviest reinforcing plate to the wall thickness and allow 1 hr./in. of total thickness.

The rate of heating above 600° F. should not exceed 400° F./hr. divided by the maximum metal thickness of the shell or head-plate, and it is desirable not to exceed these rates at temperatures below 600° F. The rate of cooling above 600° F. should not exceed 500° F./hr. divided by the maximum metal thickness of the vessel in in. The temperature gradient in the metal of the chamber should not exceed 250° F. within any 15 ft. of lineal distance during the heating period, and the whole vessel should be within 150° F. during the soaking period.

It has been found practical and much more economical to do the work in the field, rather than to dismantle the unit and send the vessel back to the manufacturer. An outline of the equipment and methods used, together with the results obtained, is discussed in this article. A. H. N.

925.* High-Chromium Alloys in the Refinery. W. L. Archer. *Refiner*, July 1941, **20** (7), 262.—Elementary metallurgical terms of steels and their alloys are explained, and the characteristics imparted to steels by incorporating chromium in varying percentages are studied in some detail. Tables and graphs are reproduced for illustrative purposes. Stainless steels—those containing chromium in excess of 11%—are studied, in particular with regard to their strengths, resistance to creep, etc., and corrosion.

Corrosion in the refinery takes place in both the hot and cold phases of operation. In the hot phase most of the damage results from the ravages of sulphur and sulphur compounds, of which there is an almost endless variety. The cold phase brings about corrosion from some sulphur compounds, although the acids are predominantly troublesome here. Among the more common acids encountered are hydrochloric, phosphoric, sulphuric, and sulphurous. In addition, organic acids may be present.

Stainless steels have been applied to many parts of the modern refinery. Among the varied uses for these alloys are bubble-caps, bubble-trays, shell linings, pumps, valves, and vapour lines. Included in the minor applications are gaskets, floats, and thermocouple protection tubes.

Both bubble-caps and bubble-trays present almost identical reasons that promote their acceptance notwithstanding a higher first cost than either cast iron or mild steel. The many operating advantages serve to make the long-term cost less than that of the unalloyed materials formerly tried. Of course the substitution of a tough, ductile material for cast iron eliminates troublesome breakage. Caps need not be replaced because of missing teeth, whilst damaged trays do not occasion costly delays.

Possibly one of the more outstanding features of the chromium alloys is their freedom from coking. The old familiar chipping away of accumulated coke during down-time is banished. In addition, this absence of coking allows longer runs and more efficient operation throughout the run, as trays and caps remain clear. The ease with which these materials may be fabricated leads to a wider variation of design, promoting further operating economies. At the same time the lighter weights of removable trays and caps leads to savings in insurance rates, as the number of accidents to workmen are reduced. Other uses and benefits are discussed.

A. H. N.

926.* **On Stream Time Increased by Insulating Headers and Return Bends.** B. G. Adams. *Refiner*, July 1941, **20** (7), 269.—By insulating headers and return bends of the cracking-still furnace, on-stream time for the cracking units was increased 25%. A description of the steps taken and an illustration of the method are given.

The insulating material used was of the plastic type. Its cost is negligible, and application and removal are simple. The wet plastic is packed, about 2 in. thick, around each header. The installation is equipped with a hinged-door header-box.

A. H. N.

927.* **Tests on Defence Gasoline Containers.** M. H. Heeren. *Refiner*, July 1941, **20** (7), 279–280.—The shipment of large quantities of gasoline overseas in face of war dangers is discussed. Handling in drums seems generally indicated. The usual heavy returnable container cannot be economical if it is not re-used, and return shipment of vast numbers of empties can only further tax an already busy transportation system. Furthermore, the substitution of the lighter pressed-steel non-returnable drum should impose less burden in the form of immediate steel demand, and at the same time permit the manufacture of greater total container capacity within a given time.

A container designed with these considerations in mind is described and tests data are given. The closure consists of a threaded flange pressed into a stamped opening in the end or side of the sheet-steel drum. The seal between the two metal surfaces is effected by a natural or synthetic rubber gasket. A threaded plug, also fitted with a gasket, is screwed into the threaded flange to complete the closure. As a further safeguard, a tamper-proof metal seal equipped with a cork ring is formed into place over the entire closure in a single operation by means of a special crimping tool.

The actual testing procedure resolved itself into establishing on a laboratory scale the conditions under which the closures would be used in practice. These conditions included submergence in salt water to a depth of 300 ft. and exposure to exceptionally severe weather conditions.

The general conclusions which can be reached from the results of the above tests are: (1) the closure of the type tested will effectively withstand sea-water pressure of 140 lb./sq. in without leakage or visible corrosion within the test period. (2) No evaporation losses and contamination by water are incurred if gasoline is stored in 18-gauge steel drums equipped with closures of above type, during storage under climatic conditions similar to those artificially produced during the 4-day test period.

A. H. N.

928.* **Appraisal of Steels for High-Temperature Refinery Service.** Claude L. Clark. *Oil Gas J.*, 27.2.41, **39** (42), 81.—Applications of steel to high-temperature service can be divided into three groups on the basis of the following conditions: (1) permissible deformation during service, (2) constant *versus* varying temperature, and (3) relative importance of strength and surface stability. In order to ascertain the information necessary to ensure a given steel rendering satisfactory service, laboratory tests, of which the author gives a comprehensive list, have been developed to study the physical properties under the combined influence of time, temperature, and stress.

Load-bearing ability, structural stability, and surface stability are the most important characteristics of steel and alloys to be studied, and the author describes in detail the laboratory tests now available, discusses the merits of these tests, and, by the ample use of graphs and photographs, gives interpretation of the results obtained.

H. C.

929.* **Metals in Refining (Corrosion Resistance and Strength of Pipe-Still Tubes).** W. L. Nelson. *Oil Gas J.*, 17.4.41, **39** (49), 179.—The resistance to sulphur corrosion that various alloys or steels may exhibit cannot be evaluated as directly as most other properties, due to a large extent to (*a*) the varying sulphur content of crude oils, (*b*) the different kinds of sulphur compounds present, and (*c*) to a less extent to differences in the manner of processing. Some effort, however, has been made to correlate sulphur-corrosion data, and it is shown that the inclusion of chromium in

steels appears to be the best way for providing immunity to this kind of attack. Silicon and aluminium in small amounts also have a pronounced effect. Calorizing will impart corrosion resistance to a steel surface, but the effect is lasting only for 12–18 months.

Molybdenum, nickel, or manganese in normal amounts have little effect on this type of corrosion, although 3% or more of molybdenum may be of assistance.

The strength of seamless steel tubes in pipe-still service is complicated by a low creep or deformation, which takes place at elevated temperatures, and because local heating effects cause variable tube-wall temperatures. Thus localized hot spots occur and embrittlement follows.

The only element which exerts a definite effect on creep or rupture strength is molybdenum. The maximum useful amount of this metal is 0·5–1·0% for creep strength, but 1·5–2·0% for rupture strength. The effect of Cr, Si, or Al on creep strength is not clear, although in large amounts Cr (plus stabilizing Ni) causes some increase. D. L. S.

930.* Close Fractionation Needed to Recover Isomers from Gas. H. W. Harts. *Oil Gas J.*, 24.4.41, **39** (50), 41.—A description is given of a plant to separate *iso*pentane, with an input of 100,000 gal. daily. Raw product is fed to the grade-gasoline fractionating column at 150 lb. pressure, where butanes and lighter are separated from pentanes and heavier. The 30,500 gal. of the latter are pumped to a second column at 50 lb. pressure to separate the 5350-gal. *iso*pentane (94% pure) as overhead from the *n*-pentane and heavier. To obtain the 99% pure product, the 94% pure *iso*pentane is pumped at 100 lb. pressure to a third tower, where the unwanted butane is removed as overhead and returned to the feed of the grade column.

The conditions and delicacy of control necessary for economic separation of *iso*butane are discussed, with reference to the fact that a *n*-butane fraction boiling 3° F. low contains 10% *iso*butane, and to the tendency of the system to become unstable and work in cycles—during a considerable proportion of which the products will be off-grade—unless the reflux ratio, pressure, and temperatures are very carefully controlled.

A plant for the manufacture of pure propane, *iso*-, and *n*-butane is also described. In this, absorption gasoline is pumped into a column, termed the de-ethanizer (actually up to 50% of the overheads may be propane). The base product of propane and heavier, after sulphur removal, is pumped to the second column, the specified gasoline taken off at the base, and the overhead *iso*- and *n*-butane and propane condensed in the reflux accumulator. Excess reflux is pumped to the de-propanizer, from which excess reflux propane is pumped through dehydrators to storage. The butanes taken off at the base are pumped to the *iso*butane column, whence excess reflux *iso*butane is pumped to storage, whilst normal butane is withdrawn from the base of the tower.

In both cases the description of the plant is accompanied by tables of throughput and composition, together with dimensions of the columns and other working conditions. T. T. D.

931.* Metals in Refining. (Steel Casting and Furnace Auxiliaries.) W. L. Nelson. *Oil Gas J.*, 1.5.41, **39** (51), 39.—The necessary properties of metals used in the various parts of pipe-stills, other than tube materials, are discussed, and tables of chemical and physical properties of suitable alloy steels are presented from which construction materials may be chosen. The tables include properties of bolting steels; casting steels for bodies, housings, and plugs of return bends; materials for tube supports in the radiant sections of stills; and materials for convection-section support of stills. Some more general remarks on corrosion and on scaling by the different types of furnace atmosphere are included. J. C.

932.* Novel Use of Shell Still Raises Kerosine Yield. Victor I. Downey and William H. Humphreys. *Oil Gas J.*, 1941, **40** (1), 52.—To meet an emergency demand for greatly increased quantities of kerosine, a refinery was called upon to process 2000 brl. of crude oil per day in excess of its pipe-still capacity. Shell stills were available, but were not provided with the necessary fractionating equipment.

The additional crude was handled in the Shell stills, and the gasoline, kerosine, and a small fraction of the gas-oil were run to storage as one cut. This cut was then used as intermediate reflux in the pipe-still fractionating column, the top reflux being correspondingly reduced.

The increased output from the column was obtained without technical difficulty or deterioration in fractionation of the products. C. G. G.

933.* **Cathodic Protection of Open Tank Condensers.** N. A. Miller. *Oil Gas J.*, 22.5.41, **40** (2), 66–68, 75.—Although the merits of cathodic protection against corrosion are well established for certain types of equipment, no published data were found relating to the use of the cathodic system for open-tank condensers. The author has therefore collected information on the results obtained at three large refineries where the system is in operation. In all cases markedly beneficial results were reported.

In addition to protecting the condenser tubes against corrosion, the use of the system affects the form of the material deposited on the tubes from the cooling water. The deposit on cathodic tubes is soft, and may easily be hosed away when the tank is emptied for cleaning, whereas without protection the tubes become covered with a hard scale. This difference in scale formation also appears to result in superior heat exchange with the protected tubes.

For this type of work the anodes usually consist of steel plates submerged vertically in the condenser tanks, although carbon anodes may also be used. The distribution of the anodes to give uniform current over the entire cathode area is of primary importance.

The source of current may be either a d.c. generator or a rectifier of the copper-oxide, selenium, or tube type, rectifiers being preferred for refinery applications. Current requirements are approximately 5–10 amp./1000 sq. ft. of cathode. Anode consumption is about 20 lb./amp./year.

The true criterion for protection appears to be the existence of a definite minimum potential of cathode with respect to electrolyte at all points. The checking of this potential is carried out using submerged test electrodes, or exploratory electrodes of the insulated-button type in conjunction with a (non-polarizing) calomel cell and null-point potentiometer, the apparatus and its application being described.

The article is illustrated with photographs. C. G. G.

934.* **Economics of Flue-Gas Recirculation and Economizers in Fired Tubular Heaters for Oil Refineries.** C. C. Nelson. *Oil Gas J.*, 22.5.41, **40** (2), 71–72, 75.—Flue-gas re-circulation involves some means of returning a portion of the outgoing flue-gas to an intermediate part of the furnace, with the object of reducing the temperature in the radiant-heat section.

Tests beginning about 1926 have shown that the system as applied to a typical cracking-coil furnace is not economically sound, and it is suggested that in the case of new equipment, suitable temperature distribution can be more advantageously obtained by modification of furnace design.

The economics of air pre-heaters are discussed in detail, and it is concluded that the maintenance and repair costs outweigh the heat savings effected, although local variations in the quality and price of fuel, and in constructional and operating charges, may invalidate this general conclusion for any particular set of conditions.

C. G. G.

935.* **Corrosion Prevention on Water Side of Refinery Equipment.** W. H. Attwill and V. L. Nealy. *Oil Gas J.*, 22.5.41, **40** (2), 81–86, 99.—The subject is dealt with under the headings: (*a*) Chemical Treatment of Water; (*b*) Use of Deaerator; (*c*) Cathodic Protection. The experiences gained by the Texas Co. at their Port Arthur and Houston refineries are reviewed under each heading.

For cooling towers, in which corrosion was initially very serious, the most satisfactory chemical treatment was that of maintaining a concentration of 500 p.p.m. of $Na_2Cr_2O_7,2H_2O$ in the water, with sufficient caustic soda to produce the normal chromate and maintain the p_H at 8·0. The presence of small amounts of phosphate

was also found to improve the corrosion resistance of the chromate film and to hinder the deposition of mineral scales on the tubes.

Sodium hexametaphosphate is under trial as a corrosion inhibitor. It has the advantage of cheapness, but its efficiency is not yet established. Sodium hydroxide and sodium silicate were not completely satisfactory.

Two years ago a mechanical deaerator was installed in one of the recirculated cooling-tower systems at Port Arthur, handling 1500 g.p.m. The deaerator consists of an asphalt-lined tower down which the water flows under high vacuum (0·4–1·2 in. Hg abs.), a system of cypress-wood trays breaking it up into films and sheets which present a large surface area to the vacuum. The dissolved oxygen content of the water is thus reduced from 6–7 p.p. million to 0·2 p.p.m. A test bundle of steel condenser tubes installed at the same time as the deaerator has now been in operation for 26 months without a failure. Previously, the life of such tubes was 5 months.

The application of cathodic protection to condensers of the shell-and-tube type is described, and a diagrammatic layout is shown for handling sixteen condensers and coolers located on a pipe-still. Whilst the system has already proved its value, much work remains to be done in determining the most satisfactory layouts and current densities for widely varying applications. C. G. G.

936.* Continental Adopts Delayed Coking at Oklahoma Plant. W. T. Ziegenhain. *Oil Gas J.*, 29.5.41, **40** (3), 42.—Delayed coking in its modern version represents a distinct improvement over the older procedure of reducing crude residuum in batch-stills to recover gas-oil as a feed for cracking stills. Both, however, recognize time as well as temperature as factors in liberating the gas-oil from the heavy residuum and in causing the deposition of coke during this procedure.

The Continental Oil Co. has converted its original Dubbs plant into a delayed coking installation for providing a desirable feed for its Cross-cracking units. A flow-sheet shows the method of operation of the process.

The raw charge is drawn from two sources: (*a*) reduced crude-gravity 22, distilling 70% to 730° F.—essentially a Kansas crude residuum; (*b*) "extraneous bottoms"—gravity 26, I.B.P. 370° F. distilling 70% to 740° F. This material comes from many sources. Reduced crude is received at a rate of 3700 brl./day and "extraneous bottoms" at 1300 brl./day. These materials are blended, mixed with 1300 brl. of recycle oil and heated to 630° F. before entering the fractionator. The plant operates in duplicate, one unit being on stream, whilst the other is cooled and cleaned out.

An important by-product of the operation is 1,800,000 cub. ft./day of gas, which is fed with the gas-oil into the cracking plant for manufacturing gasoline. In this plant 2900 brl. heavy virgin gas-oil mixed with 4100 brl. coker distillate are processed daily. D. L. S.

937.* Solutizers Improve Treating of Four Types of Gasoline. H. N. La Croix. *Nat. Petrol. News*, 5.3.41, **33** (10), R.72.—The need for developing the maximum possible octane number in gasoline has emphasized the importance of the presence in the gasoline of mercaptans not removed by the normal treating processes. The deleterious effect of these sulphur bodies on lead susceptibility necessitates the improvement of caustic washing. The higher mercaptans are only sparingly soluble in caustic, and greatly improved results have attended the addition of "solutizers" such as sodium or potassium salts of *iso*butyric acid. H. G.

938.* Clad Steels Find Place in Refinery Equipment. Anon. *Nat. Petrol. News*, 19.3.41, **33** (12), R.82.—Considerable advances in the preparation of composite metals have been made whereby it becomes possible to procure big economies in the use of high-priced corrosion-resisting alloys. Several methods are in use: casting-on processes, pressure welding, fusion welding, and electrical resistance welding. Twelve processes that come under these headings are dealt with. In addition to these processes, which produce sheet metal, there are those applicable to prefabricated plant. Anti-corrosion linings are fitted either by welding strips of corrosion-resistant alloys to the surface to be protected, or by coating the surfaces by means of high-pressure spray guns using wire or powdered metal. H. G.

939.* Refinery Uses of Moulded Carbon. M. J. Dorcas. *Nat. Petrol. News*, 30.4.41, **33** (18), R.134.—Moulded carbon articles are now available in a wide range of form, from simple packing rings to plant sections of complex shape. Size-graded carbon, usually ground petroleum coke, is mixed with tar or pitch to a plastic state and moulded under heat and pressure. The articles are then heat-treated in an electric furnace to carbonize the binder. By adjusting the furnace conditions the final product may be of amorphous carbon or graphite. Porosity is adjusted by selection of the particle size of the base material, and complete imperviousness is achieved by impregnating with synthetic resins. The almost total inertness of carbon renders it particularly valuable in many refinery processes. Amorphous carbon has a low thermal conductivity and graphite a high thermal conductivity. Articles of the former may be used for heat insulation, whilst heat exchangers have been constructed from the latter. A complete scrubbing tower weighing 250 tons and Cottrell precipitator towers have been constructed entirely of moulded carbon sections.

H. G.

940.* Alkylation Feed-Stock Produced in Natural Gasoline Plants. H. W. Harts. *Nat. Petrol. News*, 14.5.41, **33** (20), R.153.—The increasing demands for high-octane motor fuels have increased the importance of adequate supplies of *iso*butane and *iso*pentane. Both these raw materials are being isolated from natural gas. The article concerns itself primarily with the economical considerations. Isolation calls for expensive equipment and extremely close plant control, and some doubt is expressed that the procedure is economically justifiable from the point of view of the natural-gas producer.

H. G.

941.* Air Preheaters for Petroleum Heaters. L. A Mekler and H. A. Becker. *Nat. Petrol. News*, 28.5.41, **33** (22), R.162.—The use of air preheaters can, if suitably operated, effect considerable fuel economies. This is an important item when the present trend is to make refinery gases more useful as raw materials for gasoline intermediates than as fuel. The position is discussed largely from the economical standpoint. It is shown that there are optimum conditions for operation, and that operation at temperatures above certain maxima may entail losses. Tables are given showing the economics of preheaters as affected by type and by changes in the preheated air temperature.

H. G.

942.* Regenerative-Type Air Heaters. O. F. Campbell and T. B. Kimball. *Nat. Petrol. News*, 28.5.41, **33** (22), R.168.—The Ljungstrom continuous-counterflow-regenerative air preheater is described and its application to a down-draft de Florez cracking still is discussed. In a table the expected performance of a cracking-still furnace in which the convection bank is substituted by an air preheater is compared with a similar furnace equipped with a convection bank. The use of the preheater is shown to produce some financial saving. Where flue temperatures exceed 1400° F. it is suggested that the use of an air preheater as an addition to the existing plant might prove more economical than the substitution of the convection bank by an air heater calling for the use of expensive high temperature alloys. The advantages and disadvantages of this type are discussed. A disadvantage is its high power requirements; advantages are its small size and the ease with which it is cleaned.

H. G.

943.* Prevention of Fog in Cooler-Condensers. A. P. Colburn and A. G. Edison. *Industr. Engng Chem.*, 1941, **33** (4), 457.—The condensation of a vapour in the presence of an inert gas usually results in some fog being formed. The theoretical mechanism of fog formation under these conditions is discussed, and a solution of the problem is to cause the path of cooling to lie always under the vapour-pressure curve, so that the mixture never becomes supersaturated. The method of eliminating this undesirable condition is to supply a small amount of heat to the vapour–gas mixture during the condensing process. The method was tested experimentally on mixtures of air with steam, butyl alcohol, and trichlorethylene. Details of the experimental technique and methods of industrial application are given.

J. W. H.

944. Elimination of Viscosity Error in Flow Measurement with Rotameters. K. Fischer, S. Blechman, and E. Lipstein. *Instruments*, 1941, **14** (3), 65.—The principal defect of the old-type rotameter with a spheroidal float has been the great variation of the calibration with change in viscosity of the flowing fluid, and the fact that this change was not predictable with sufficient accuracy by the Schoenburn–Colburn equation relating rotameter dimensions with flow velocity and the physical properties of the fluid. A wire-guided disc-type float has been developed in which the disc forming the flow restriction and the body required to give the necessary weight are separated by attachment to opposite ends of a tube of small diameter. The body of the float is located in a pocket of stagnant liquid and is not subject to viscous drag. This type of float indicates flow rates which are independent of viscosity and in agreement with the Schoenburn–Colburn equation. The use of this new type of rotameter in conjunction with a rotameter having a plug-float enables changes in viscosity of the flowing fluid to be continuously recorded, and, if used in conjunction with a very light disc-float rotameter, the latter instrument acts as a continuous indicating pycnometer. J. W. H.

945.* Desulphurizing Properties of Zinc Hydroxide. K. A. Musatov and L. G. Krymova. *J. appl. Chem.* (*U.S.S.R.*), 1940, **13** (12), 1804–1809; translated by A. A. Boehtlingk, *Foreign Petrol. Tech.*, March 1941, **9** (3), 112–121.—It has previously been established (see Abstract 629) that the basic products of the hydrolysis of zinc chloride (ZnO and $Zn(OH)_2$) are of primary importance in the degree of desulphurization of the distillates and for the combination of hydrogen sulphide. Further investigations have now been carried out to support this statement. Zinc hydroxide has been found to desulphurize the distillates more thoroughly than zinc oxide. The temperature of the desulphurization with zinc hydroxide has an optimum which is determined by the degree of the thermal dissociation of the sulphur compounds of the distillate and the pliability of the decomposition of the hydroxide into the oxide and water. For crude-oil distillates the highest desulphurization temperature with zinc oxide at atmospheric pressure lies within 360–370° C. B. M. H. T.

946. Crude Benzole Fractionation. Anon. *Chem. Tr. J.*, 27.6.41, **108**, 379.—A brief account of E.P. No. 536,172, which covers the preparation of pure or nitration grades of benzol, toluol, and xylol by azeotropic distillation of crude benzoles with methanol. C. G. G.

947. Patents on Refining and Refinery Plant. Standard Oil Development Co. E.P. 536,819, 28.5.41. Appl. 21.11.39. A method of separating olefins, having from 2 to 4 carbon atoms per molecule, from saturated gaseous hydrocarbons. The olefins are absorbed in an aqueous ammoniacal solution of cuprous benzine sulphonate at between − 10° and 25° C. Saturated hydrocarbons are only negligibly dissolved. The olefins are recovered by application of heat, or by reducing the pressure. Also, a method of storing such olefins by solution at low temperature and under pressure in the above reagent.

A. L. Snow. U.S.P. 2,241,430, 13.5.41. Appl. 7.2.38. A petroleum fraction is subjected to a plurality of reforming operations, approaching the ultimate end-point of the reforming reaction in a number of steps. The reformed reaction products are selectively dissolved by contacting the hydrocarbons from at least one of the reforming operations with a liquid solvent having a selective solvent action for aromatic and unsaturated hydrocarbons. The mixture of selective solvent and dissolved hydrocarbons is fractionated by intimately mixing with additional vapour-phase hydrocarbons from a reforming operation, separating a vapour-phase raffinate from the selective solvent, and subjecting it to at least one reforming operation.

S. C. Carney. U.S.P. 2,242,110, 13.5.41. Appl. 12.1.38. A method of controlling the evolution of dissolved gases from a continuous stream of hydrocarbon liquid under high pressure. The stream is passed consecutively into a number of vessels. The pressure is gradually reduced in each vessel after the stream has been directed to the next, the reduction in pressure being continuous over a period sufficient to obtain maximum evolution of dissolved gas with minimum loss of the less-volatile com-

ponents. The rate of pressure reduction is controlled by the amount of vapour evolved. The liquid from each vessel is discharged before the pressure has dropped to a value at which the less volatile constituents are appreciably evolved.

W. A. Schulze and G. H. Short. U.S.P. 2,242,621, 20.5.41. Appl. 28.5.40. In the process of sweetening hydrocarbon oil with copper reagents, stabilization of the sweetened oil to prevent deterioration due to retained oil-soluble copper salts, is achieved by adding a small quantity of dithizone.

W. L. Benedict and J. E. Ahlberg. U.S.P. 2,243,824, 27.5.41. Appl. 22.3.39. Process for refining hydrocarbon distillate consists of sweetening with a copper containing reagent, separating, treating in the presence of a heavy metal sulphosilicate to remove copper, and recovering the sweet gasoline.

T. P. Simpson, J. W. Payne, and P. D. Valas. U.S.P. 2,245,016, 27.5.41. Appl. 25.5.39. An adsorptive material for refining solvent-refined petroleum oils. It consists of a finely divided porous material covered with a layer of activated charcoal derived from petroleum carbonaceous matter.

R. F. Farris. U.S.P. 2,245,028, 27.5.41. Appl. 2.6.39. Liquid hydrocarbons from moisture containing well-fluids. In wells of the distillate type such a fluid is produced at high well-head pressure. It is cooled to a temperature above the maximum for hydrate formation, thus condensing most of the water. The cooled fluid is separated, and water is removed from the system. The gas phase is passed at a pressure greater than 1000 lb./sq. in. into a liquid absorption medium less volatile than the liquid hydrocarbons to be recovered, and separating the enriched absorption medium from residual gas.

C. G. Gerhold. U.S.P. 2,245,143, 27.5.41. Appl. 13.4.39. In order to avoid inactivation by loss of water of hydrated catalysts, sufficient quantities of an aqueous fluid are added to reactant at spaced points in the path of flow to prevent dehydration of catalyst.

F. B. Allen. U.S.P. 2,245,549, 27.5.41. Appl. 17.5.38. Quenching fluid-coked petroleum residue. The material is flowed through a conduit, and discharged in a solid stream. Numerous jets of water are directed downwards and radially inwards, disintegrating the hot fluid material, which falls into a tank of water below in the form of small fragments. H. B. M.

Fire Prevention.

948. Some Information on the Causes and Prevention of Fires and Explosions in the Petroleum Industry. G. M. Kintz. *U.S. Bur. Mines, Information Circular*, 7150, April 1941.—This circular has been written with a view to instructing people how to prevent loss of life and property by fire and explosion due to accidental combustion of natural gas, petrol, and related fuels. It is pointed out that fire or explosion of inflammable gas can occur only when its volume bears a definite relationship to the volume of air present; the mixture must then be in contact with sufficient heat to cause it to ignite. Therefore fire once started can only be put out by removing the fuel, air, or heat. Stress is laid on the danger of using "unapproved" electrical equipment anywhere where inflammable vapours may persist. Fuses, electric-light bulbs, drop-cord attachments, and the like should never be changed or adjusted while the current is on, in any circumstances where inflammable vapours may penetrate. Similarly, the use of petrol as a cleaning agent, as is well known, is, under certain conditions, likely to cause explosion, and should therefore never be allowed.
H. B. M.

949.* Fighting Fires with Carbon Dioxide Extinguishers. P. W. Eberhardt. *Oil Gas J.*, 29.5.41, **40** (3), 48.—The portable carbon-dioxide extinguisher is well known to the oil industry. It consists of a cylinder of the gas at 850-lb. pressure, and is operated by a small hand-wheel. The CO_2 is discharged through a nozzle designed so that the gas hits the fire with a minimum of turbulence.

These units are available in sizes ranging from the small pistol type containing 2 lb. CO_2 to the big, wheeled unit with a capacity of 100 lb. gas. In the early days it was considered that the smothering effect of CO_2 was not effective in the open air, but it is now recognized that many types of out-of-doors fires can be effectively controlled by this means.

These extinguishers are approved for electrical and flammable liquid fires, and, in addition, are unusually effective against running fires. The oil industry is using them in large numbers to protect such hazards as natural gasoline and recycling and repressuring plants, as well as for control-rooms located under stills.

Built-in CO_2 systems are becoming popular in the refining and distributive phases of the industry, and can be operated automatically. D. L. S.

Chemistry and Physics of Petroleum.

950. Densities and Refractive Indices of Liquid Paraffin Hydrocarbon. M. L. Huggins. *J. Amer. chem. Soc.*, 1941, **63**, 116–120.—The relationship between the structures of paraffin hydrocarbons and their densities and refractive indices at 20° C. has been studied in the light of recently published data, and general equations are suggested for molal volumes and refractions. T. C. G. T

951. Common Basis of Intramolecular Rearrangements. VII. Inapplicability of a Free Radical Mechanism. Formation of 1 : 1-Dimethyl*cyclo*propane and Neopentane by the Action of Sodium on Neopentyl Chloride. Relation to the Mechanism of the Wurtz Reaction. F. C. Whitmore, A. H. Popkin, H. I. Bernstein, and J. P. Wilkins. *J. Amer. chem. Soc.*, 1941, **63**, 124–127.—The products of the reaction of 1 mole of neopentyl chloride and 1 mole of sodium were 13% 2 : 2 : 5 : 5-tetramethylhexane, 36% neopentane, 25% 1 : 1-dimethyl*cyclo*propane, and a trace of *iso*butylene. From the reaction of 5 moles of neopentyl chloride and 1 mole of sodium 41% neopentane, 51% 1 : 1-dimethyl*cyclo*propane, a trace only of 2 : 2 : 5 : 5-tetramethylhexane, and no *iso*butylene was yielded.

The bearing of these results on the mechanism of molecular rearrangements and of the Wurtz reaction is discussed. T. C. G. T.

952. Heats of Organic Reactions. X. Heats of Bromination of Cyclic Olefins. M. W. Lister. *J. Amer. chem. Soc.*, 1941, **63**, 143–149.—The heats of hydrogenation and bromination of unsaturated organic compounds in the vapour phase, and which have been published previously, indicated a regular relationship between these properties and the molecular structure. The work has now been extended to the reactions in the liquid state, and the relationship previously noted is confirmed. It is concluded that a theory which assumes repulsive forces between non-bonded adjacent atoms is more consistent with the experimental evidence than one assuming attraction.

A specially designed vacuum calorimeter is described. T. C. G. T.

953. Further Observations on the Absorption Spectra of Derivatives of 1 : 2-Benzanthracene. R. N. Jones. *J. Amer. chem. Soc.*, 1941, **63**, 151–155.—In the course of studies on the carcinogenic properties of hydrocarbons a large number of derivatives of 1 : 2-benzanthracene were prepared. These preparations have now been utilized to determine the effect of a given substituent at a given position of the spectrum of the hydrocarbon.

Observations on the fluorescence of most of the derivatives are also recorded. T. C. G. T.

954. Synthesis of 4 : 5-Methylenephenanthrene. W. E. Bachmann and J. C. Sheehan. *J. Amer. chem. Soc.*, 1941, **63**, 204–206.—4 : 5-Methylenephenanthrene has been prepared from acenaphthene. T. C. G. T.

955. Preparation of Higher *cis*- and *trans*-Olefins. K. N. Campbell and L. T. Eby. *J. Amer. chem. Soc.*, 1941, **63**, 216–219.—Most methods of preparing olefins yield a mixture of the two geometrical isomers. In the case of the lower members—*e.g.*,

2-butene—these can be separated by fractional distillation, but in the case of higher members the boiling points become so close that fractional distillation as a method of separation is impracticable.

The reduction of dialkylacetylenes can be controlled to yield either *cis*- or *trans*-olefins. *cis*-Olefins are prepared by catalytic hydrogenation in the presence of Raney nickel, and *trans*-olefins by the reduction of dialkylacetylenes with sodium in liquid ammonia.

Four pairs of *cis*- and *trans*-isomers, 5-decene, 4-octene, 3-octene, and 3-hexene are described, and their configuration is established by means of Raman spectra, freezing points, and dielectric constants. T. C. G. T.

956. Action of Anhydrous Ferric Chloride on Alkylbenzenes. D. Nightingale, R. G. Taylor, and H. W. Smelser. *J. Amer. chem. Soc.*, 1941, **63**, 258–261.—When 1 : 3-dimethyl-4-butylbenzenes are warmed with anhydrous ferric chloride the reactions are generally similar to the reaction with anhydrous aluminium chloride.

The 1 : 3-dimethyl-4 : 5-*s*.- and 4-*tert*.-butylbenzenes undergo rearrangement to 1 : 3-dimethyl-5-*tert*.-butylbenzene when warmed with ferric chloride at 80° C. Some 1 : 3-dimethyl-5-*tert*.-butylbenzene is formed from the 4-*iso*butylhydrocarbon, but a higher temperature is required. This is also true of the 4-*s*.-butylhydrocarbon.

Only unchanged 1 : 3 : 4-hydrocarbon was isolated from the two 1 : 3-dimethyl-4-propylbenzenes and 1 : 3-dimethyl-4-ethylbenzene, after warming them with ferric chloride at temperatures up to 150° C. T. C. G. T.

957. Note on the Absorption Spectra of some Alkyl Chrysenes. R. N. Jones. *J. Amer. chem. Soc.*, 1941, **63**, 313–314.—In the course of studies on the carcinogenicity of hydrocarbons the absorption spectra of 5-methyl-, 4 : 5-dimethyl-, 5 : 6-dimethyl-, and 4 : 5-methylene-chrysene have been determined and are recorded. T. C. G. T.

958. Nitrogen Compounds in Petroleum Distillates. XIX. Isolation from California Petroleum and Synthesis of 2 : 3 : 8-Trimethyl-4-Ethylquinoline. R. A. Glenn and J. R. Bailey. *J. Amer. chem. Soc.*, 1941, **63**, 637–638.—A new $C_{14}H_{17}N$ base, 2 : 3 : 8-trimethyl-4-ethylquinoline (*A*), was isolated from the 308–315° C. fraction of bases obtained from the Edeleanu extract of California petroleum. It was degraded to the hitherto unknown 2 : 3-dimethyl-4-ethylquinoline (*B*).

A is the first quinoline homologue obtained from this source with an alkyl on the Py-nucleus higher than methyl. The structures of *A* and *B* were confirmed by synthesis. R. D. S.

959. Nitrogen Compounds in Petroleum Distillates. XX. Isolation of 2-Methyl-8-ethylquinoline from California Petroleum and Proof of Structure through Degradation and Synthesis. R. A. Glenn and J. R. Bailey. *J. Amer. chem. Soc.*, 1941, **63**, 639–641.—The isolation of two new $C_{12}H_{13}N$ bases occurring in 258–264° C. fraction from the Edeleanu extract of California petroleum is reported. Proof of the structure of one as 2-methyl-8-ethylquinoline is described. R. D. S.

960. High-Temperature Photolysis of Acetone and the Action of Free Methyl Radicals on Propane. Augustine O. Allen. *J. Amer. chem. Soc.*, 1941, **63**, 708–714.—Acetone illuminated by light of wave-lengths between 2000 and 3000 A. is known to break up cleanly to free methyl and acetyl radicals. Part of this paper includes data on products obtained by the illumination of acetone propane mixtures. The products of reaction were methane, ethane, propane, normal and *iso*butane, pentane (probably from secondary reaction), and carbon monoxide. Hydrogen and unsaturateds were not formed. R. D. S.

961. Synthesis of Multi*cyclo*pentyls. G. E. Goheen. *J. Amer. chem. Soc.*, 1941, **63**, 744–749.—With a view to a possible relationship between the multicyclic five-carbon membered rings and the structure of petroleum products, various multi*cyclo*pentyls were synthesized. The physical properties determined were: boiling point at atmospheric and reduced pressure, refractive index at two temperatures, density at five

temperatures, specific dispersion, viscosity at five temperatures, V.I., aniline point. The V.I. was found to decrease as the number of rings increased, but the highest examined, $C_{20}H_{34}$, still had a V.I. of more than 100. R. D. S.

962. Chlorination of Olefins in Reactive Solvents with *tert.*-Butyl Hypochlorite. C. F. Irwin and G. F. Hennion. *J. Amer. chem. Soc.*, 1941, **63**, 858–860.—This paper describes twenty reactions between various olefin hydrocarbons and *tert.*-butyl hypochlorite in the presence of alcohols, phenol, or acetic acid. These solvents take part in the over-all reaction, the products being chlorhydrins or esters. R. D. S.

963. Preparation of 2 : 2- and 3 : 3-Dimethylpentane. H. Soroos and H. B. Willis. *J. Amer. chem. Soc.*, 1941, **63**, 881.—The authors describe how it is possible to prepare these hydrocarbons by the condensation of tertiary alkyl halides with Grignard reagents. R. D. S.

964. Effect of Potassium Oleate on Solubility of Hydrocarbon Vapours in Water. J. W. McBain and J. J. O'Connor. *J. Amer. chem. Soc.*, 1941, **63**, 875–877.—The authors studied the solubilities of the indifferent hydrocarbons, *iso*butane, butadiene, and propylene in water and in solutions of potassium oleate, and found that the presence of the soap enhanced the solubility. R. D. S.

965.* Mechanism of Hydrogenation of Unsaturated Hydrocarbons. Composition of Technical Di*iso*butylene. R. Obolentsov. *J. appl. Chem.* (*U.S.S.R.*), 1940, **13** (2), 198–209; translated by A. A. Boehtlingk, *Foreign Petrol. Tech.*, March 1941, **9** (3), 87–106.—An attempt to identify, from their physical constants, the separated narrow cuts in the fractionation of di*iso*butylene (the raw material for the preparation of *iso*-octane) was unsuccessful, owing to the impossibility of effecting a sufficiently sharp fractionation. The authors therefore applied ozonation, and identified the derivatives of the products of hydrolysis of the ozonides. As a result, eight isomeric octylenes and two isomeric nonylenes were formed in the di*iso*butylene. All the octenes present contain in their hydrocarbon skeleton a tertiary carbon atom with the exception of one (2 : 4-dimethylhexene-5), and they are hydrocarbons with a slightly branched chain. It is considered that further branching is scarcely possible in the hydrogenation of these hydrocarbons and the reversed process is also improbable. B. M. H. T.

966.* Mechanism of Hydrogenation of Unsaturated Hydrocarbons. Composition of the Octylene Fraction of Commercial Di*iso*butylene. R. Obolentsev. *J. appl. Chem.* (*U.S.S.R.*), 1940, **13** (12), 1869–1871; translated by A. A. Boehtlingk, *Foreign Petrol. Tech.*, March 1941, **9** (3), 107–111.—Investigations have been carried out on the structure of the olefin hydrocarbon present in the fraction boiling at 125–126° C. of the polymers obtained in the treatment of unsaturated gases with sulphuric acid. B. M. H. T.

967.* Line Co-ordinate Chart for Vapour Pressures of Organic Solvents. D. S. Davis. *Industr. Engng Chem.*, 1941, **33** (3), 401.—A nomogram is presented which enables the vapour pressures up to the boiling point of the following solvents to be estimated: *iso*-octane, *iso*decane, ethylene glycol monoethyl ether, di*iso*butylene, di*iso*amylene, diacetone alcohol, *n*-butyl acetate, and *n*-amyl acetate. J. W. H.

968. Calculating Beattie–Bridgeman Constants from Critical Data. S. H. Maron and D. Turnbull. *Industr. Engng Chem.*, 1941, **33** (3), 408.—From a general equation for $\log_{10} \gamma$ as a function of reduced temperature and pressure for any gas, expressions are derived relating the Beattie–Bridgeman constants of the gas to the Beattie–Bridgeman constants of a reference gas in terms of critical pressure and temperature only. The Beattie–Bridgeman constants thus calculated for various gases are used to evaluate their compressibilities, and calculated results are compared with observed data and with the van der Waal equation. Compressibilities calculated by the method

described agree with the observed data over a wide temperature and pressure range, and are superior to the results of the van der Waal equation at all the temperatures except in the 1·00–1·25 reduced temperature interval. J. W. H.

969.* Role of Diffusion in Engineering Operations. T. K. Sherwood. *Industr. Engng Chem.*, 1941, **33** (4), 424.—This paper is an introduction to a diffusion symposium comprising some 12 papers. The basic principles of diffusion are reviewed and their interpretations emphasized. The application of fundamental diffusion theory to selected examples of absorption, combustion, catalytic hydrogenation and water-cooling tower design is discussed. J. W. H.

970.* Gas Absorption in Bubble-Cap Columns. J. F. Walter and T. K. Sherwood. *Industr. Engng Chem.*, 1941, **33** (4), 493.—Data are presented on the absorption of propylene and *iso*butylene from an inert gas at 3·14 and 4·19 atmospheres in a 2-in. single-plate column fitted with a segment of a 2-in. cap using a heavy naphtha, a gas oil, and a heavy gas oil–lubricating oil mixture. Under various conditions Murphree vapour efficiencies of 4·7–24·0% were obtained. Using the same column for the rectification of alcohol and humidification of air, Murphree vapour efficiencies of 78–92% were obtained. Data on the absorption NH_3 and CO_2 from air by means of water and the desorption of CO_2 from water and aqueous glycerol solution into larger columns are given. For the absorption of NH_3 a Murphree vapour efficiency of 70% was obtained, but for the absorption and desorption of CO_2 the efficiency was 0·65–4·2%. These absorption experiments were carried out over a range of vapour and liquid velocities which corresponded to commercial practice. The results are correlated approximately by an empirical equation relating the Murphree vapour efficiency to the gas solubility, total pressure, liquid viscosity, slot width, and effective depth on the plate. The major variable is the gas solubility and the results indicate that different efficiencies should be used for each component in the design of absorbers for natural and refinery gases. J. W. H.

971.* Relations between Physical Properties of Paraffin Hydrocarbons. A. W. Francis. *Industr. Engng Chem.*, 1941, **33** (4), 554.—Boiling, melting and aniline points, densities, refractive indices, and octane numbers are given for 88 paraffins between C_1 and C_{16}. Equations which are functions of the number of carbon atoms only are derived which reproduce the densities, refractive indices, and boiling points of the normal and other homologous branch chain series. For each isomeric paraffin the aniline point is shown to be a linear function of the density or refractive index and the octane number is a linear function of 1000 times the density minus twice the boiling point. These relations are used to detect errors in the literature, to estimate unknown properties and to predict the properties of unknown isomers. J. W. H.

972.* Free Energies of Formation of Gaseous Hydrocarbons and Related Substances. C. M. Thacker, H. O. Folkins, and E. L. Miller. *Industr. Engng Chem.*, 1941, **33** (5), 584.—The free energies of formation have been calculated for seventy-seven hydrocarbons and eight inorganic compounds in the gaseous state, over the temperature range 298–1200° K. The tables include values for the *n*-paraffins from C_1 to C_{16}, thirty-two branched-chain paraffins between C_4 and C_8, the 1-olefins from C_2 to C_{16}, and twenty-six branched-chain olefins. The experimental values of the entropy, heat of formation, and specific heat–temperature relationship used in the standard free energy of formation equation are given. J. W. H.

973.* Liquid-Vapour Equilibrium Relations in the Binary System *n*-Butane–*n*-Heptane. W. B. Kay. *Industr. Engng Chem.*, 1941, **33** (5), 590.—The P.V.T.-x relationship at the liquid- and vapour-phase boundaries of the system *n*-butane–*n*-heptane have been determined. Comparison of the data obtained on this system is made with that previously published by the author for the system *n*-butane–ethane. Phase equilibria constants for both systems are compared with the values calculated from the fugacities. J. W. H.

974.* Thermal Properties of Pentane. P. R. Konz and G. Granger Brown. *Industr. Engng Chem.*, 1941, **33** (5), 617.—The effect of pressure and temperature on the enthalpy of pentane has been determined by means of the Joule–Thomson expansion for pressures up to 3000 lb./sq. in. and temperatures up to the decomposition point. The specific heat of pentane at atmospheric pressure has been calculated by differentiating the enthalpy–temperature equation, and the results are in good agreement with the experimentally determined specific-heat temperature relationship. J. W. H.

975.* Solubility of Methane in *n*-Hexane. E. P. Schoch, A. E. Hoffmann, and F. D. Mayfield. *Industr. Engng Chem.*, 1941, **33** (5), 688.—The solubility of methane in *n*-hexane over the temperature range 100–220° F. and at pressures up to the critical is reported in the form of bubble-point data. The specific volumes of the liquid phases, together with the compressibilities up to 6000 lb./sq. in. are given. Comparisons of this system with the systems methane–*cyclo*hexane and methane–benzene are made. J. W. H.

976.* Contact Phenomena Changing the Chemical Nature of Hydrocarbons. N. D. Zelinskii. *Refiner*, July 1941, **20** (7), 271–278.—The paper is a translation from the Russian, the introductory part of the original manuscript having been condensed and the remainder literally translated.

Research on catalytic reactions carried out by N. D. Zelinskii and his co-workers is reviewed. Formation of intermediate compounds composed of the reactants and the catalyst is not a necessary pre-requisite for a catalytic reaction. The catalyst changes the dynamic properties and the form of the molecules, and thus accelerates their interaction. The destructive action of nickel catalysts can be prevented by depositing nickel on alumina. *cyclo*Hexanes are distinguished by their selective dehydrogenation to aromatics, which is not observed in the case of other naphthenes. The phenomenon of irreversible catalysis consists in redistribution of the hydrogen of *cyclo*hexenes with formation of naphthenes and aromatics. On bi- and tri-cyclic hydrocarbons five-member rings can withstand hydrogenation and dehydrogenation, whilst three- and four-member rings are decomposed. However, cases are listed in which *cyclo*pentanes also undergo a scission of their ring in hydrogenation over platinum. Cyclization of *iso*paraffins, of a paraffin chain connecting two naphthene rings, and aromatization by conversion of a *cyclo*pentane into a *cyclo*hexane, followed by dehydrogenation of the latter, are cited. Contact with platinum or palladium may effect a shift of the double bond of olefins or stereoisomerization.

There seems to be no basis for an assumption that in all catalytic processes formation of intermediate temporary compounds from the reacting substances and the contact bodies takes place. The author agrees with Mendeleev that a mere contact is sufficient to bring about a dynamic strain in the molecules, which results in some cases in rupture of the ring, its isomerization, or in creation of a new ring from open chains changing the energy level of the valence bonds, whilst in other cases the ring of *cyclo*hexane is completely dehydrogenated to benzene.

All above-mentioned phenomena that change the chemical nature of hydrocarbons depend on simple contact with metal catalysts prepared in a definite way. With regard to decomposition of *cyclo*hexane into hydrogen and benzene, it may be regarded as a dissociation at a considerably lower temperature (beginning with 150° C.) under the action of the contact substances. Out of contact with these metals the stability of the *cyclo*hexane is so high that even at much higher temperatures it does not undergo dehydrogenation.

These studies were started because of their theoretical significance, but the derived conclusions were found to be also of practical use. The contact aromatization of gasoline and ligroin fractions of oil constitutes a method of preparation of large amounts of aromatics. Conversion of *cyclo*pentanes into *iso*paraffins is also of practical importance. A. H. N.

977.* Obtain Up to 37% *iso*-Octane in Catalytic Isomerization. A. P. Sivertsev. *Nat. Petrol. News*, 5.3.41, **33** (10), R.68.—Laboratory experiments on the isomerization of *n*-octane are described. Simple heating yields a maximum of 10% of isomers. In the presence of anhydrous aluminium chloride the maximum yield was 37%, the optimum conditions being 1–2 hrs. heating at 120–140° F. *n*-heptane treated for 5 hrs. at 104° F. yielded 16% of isomers. H. G.

978.* Viscosities of Homologous Series at Equal Temperatures. A. H. Nissan and A. E. Dunstan. *J. Inst. Petrol.*, June 1941, **27** (212), 222.—It appears that log μ is connected more directly with molecular volume than with molecular weight. The formula

$$\log \mu = A \log (\text{molecular volume}) + B$$

applies to a greater extent than the original

$$\log \mu = A (\text{molecular weight}) + B.$$

when a wide range of members of homologous series is considered. The molecular volume formula, however, is still far from being comprehensive. B. M. H. T.

979.* Petroleum as a Raw Material. A. W. Nash. *J. Inst. Petrol.*, June 1941, **27** (212), 195.—The subject is treated from the point of view of the isolation of pure chemical entities from or through the intermediary of petroleum. The properties and applications of compounds are considered under six headings: saturated, unsaturated and oxygenated open-chain groups of hydrocarbons, cyclic compounds, sulphur compounds, and nitrogen compounds. B. M. H. T.

980.* Synthesis of Some Diolefin, Olefin, and Other Hydrocarbons and their Polymerization in Electric Discharges. Part I. Synthesis of Unsaturated Alcohols and their Dehydration. K. I. Karasev. *J. gen. Chem. U.S.S.R.*, 1940, **10** (18), 1699–1703; translated by A. A. Boehtlingk. *Foreign Petrol. Tech.*, April 1941, **9** (4), 128–136.—The greatest difficulty experienced in the synthesis of alcohols of the structure of heptene-1-OL-4 consisted in the impossibility of obtaining the Grignard complex in the usual manner from allyl chloride with a more or less satisfactory yield. By means of adding small amounts of aldehyde to the allyl halide in the process of preparing the Grignard complex, the yield of the latter was increased for allyl bromide up to 85% and for allyl chloride up to 70–75% of the theoretical yield. This enabled the yield of alcohols to be increased to 55–65% of the theoretical yield. The most successful method of dehydrating the alcohol was found to be that developed by Chugaev. The sodium alcoholate obtained by refluxing the heptanol with ether and sodium was decanted and treated in the cold with CS_2 and CH_3I. The reaction is exothermic. After further heating, washing, and drying with $CaCl_2$, the remaining ether and CS_2 were distilled off. On further heating the xanthate ether was subjected to the usual decomposition with the formation of the diene hydrocarbon. The hydrocarbon obtained was subjected to a repeated re-distillation, first without sodium and then over sodium for the removal of traces of methyl-mercaptane. The synthesis and dehydration of decene-1-OL-4 were carried out in a similar manner. The constants of the hydrocarbons obtained were determined and the structure proved. B. M. H. T.

981.* Synthesis of Some Diolefin, Olefin, and Aromatic Hydrocarbons and their Polymerization in Electric Discharges. Part 2. K. I. Karasev. *J. gen. Chem. U.S.S.R.*, 1940, **10** (18), 1704–1712; translated by A. A. Boehtlingk. *Foreign Petrol. Tech.*, April 1941, **9** (4), 137–150.—It has been found that in all cases of electric polymerization of hydrocarbons there is a sharp decrease in the iodine numbers, which greatly exceeds the decrease in the hydrogen number. By means of oxidation and other methods, it has been established that the chemical changes of the substance subjected to treatment with a silent discharge take place in the direction of an increase in the molecular weight, a shifting of the double bonds of the salts from position 1 : 4 to position 1 : 3, formation of new double bonds, and evidently cyclization. The migration of olefin bonds into the conjugated position amounts up to 70% of the total double bonds in the case of pure diene hydrocarbons, whilst it is still higher in the case of mixtures with mono-olefins. Chemical changes leading to the formation of conjugated diolefin systems are sharpest during the consumption of the first KWh. of energy. Later, other processes prevail, including cyclization. As a result of this, the percentage of conjugated bonds in comparison with the total number of double bonds does not increase, but, on the contrary, sharply decreases. In the case where the original product is a mixture of mono- and di-olefin hydrocarbons, the process of the formation of conjugated double bonds is not discontinued as rapidly as is the case with pure diolefin hydrocarbons. B. M. H. T.

Analysis and Testing.

982.* Consistency Determinations Improved for Fluid Greases. Anon. *Nat. Petrol. News*, 22.1.41, **33** ((4), R.32.—The S.I.L. Mobilometer is a modification of the Gardner Mobilometer, which is stated to be unreliable when used on very fluid greases. The modified instrument consists of a cone fitted to a shaft and mounted so as to move vertically within a tall water-jacketed cylinder. The cone is pierced by a number of holes with axes parallel to the axis of the shaft. Consistencies are determined by measuring the time taken for the shaft to fall a predetermined distance through the worked grease at 77° F. The " consistency number " is calculated from the formula $C.N = \frac{\sqrt[4]{LT}}{500}$, where L = load on the cone and T = time in seconds. H. G.

983.* Speeds Viscosity Measurement in Capillary Type Viscometer. E. H. Zeitfuchs. *Nat. Petrol. News*, 16.4.41, **33** (16), R.121.—The viscometer described is of the Ostwald type. The trap, in which the correct volume of oil is automatically measured, is situated at the bottom of the tube. Errors due to differences in surface tension are eliminated by so proportioning the tube that liquid in both sides flows in sections of equal diameter. The viscometer is available in four sizes, covering the range 1–1000 c.s. Special sizes appropriate to other viscosity ranges may be made. H. G.

984.* Vapour-Pressure Determinations Affected by Many Variables. F. M. Allen. *Oil Gas J.*, 24.4.41, **39** (50), 50.—This paper reports critically on all the modifications that have been made in the method of determination of Reid vapour-pressures since the introduction of the test. Conclusions are : the volumetric ratio of air- to gasoline-chamber should be as near 4 : 1 as possible. The sample should be properly aerated. When cleaning out the apparatus the rinsing water should be as near air temperature as possible, to ensure a correct value of the " initial air temperature." When determining the latter, the thermometer should be supported by a loosely fitting cork in the neck of the air-chamber to ensure that the air is saturated with water-vapour.

The question of the advisability of avoiding the temperature correction by having an " initial air temperature of 100° F." is gone into in some detail. The errors introduced by this modification are shown to result from the air in the chamber cooling below 100° F., contracting and sucking in more cold air in the interval (up to 10 secs.) elapsing from the time when the chamber is removed from the 100° F. bath until it is connected to the gasoline chamber. The conclusion is that determinations can be simplified by using the 100° F. " initial air temperature," provided that adequate precautions are taken to ensure that the temperature of the saturated air in the chamber is 100° $\pm$ 0·5° F. at the instant of final closure. T. T. D.

985.* Revised Charcoal Adsorption Test Adopted by Committee. H. L. Oder. *Oil Gas J.*, 24.4.41, **39** (50), 54.—The principal changes are : the dry, orifice, or wet meter is replaced by a diaphragm meter. A back-pressure regulator is placed on the meter outlet, so that an absolute flowing pressure equal to the required base pressure can be maintained, thus eliminating pressure corrections. The quantity of activated charcoal is changed from 250 c.c. to 130 gm., and grain size 6–14 mesh is tightened to 8–14 mesh, as determined by Tyler screens. The activation period of 40 min. is widened to 40–45 min.

The new activation test for the charcoal is still being worked out.

The charcoal moisture content test is that not less than 5 ml. water shall be recovered when 130 gm. charcoal are distilled with 100 ml. clean kerosine. The charcoal saturation is such that 30 $\pm$ 5 ml. net gasoline shall be recovered by distillation with 200 ml. (instead of 150 ml.) glycerol up to a final temperature of 400° F. (instead of 350° F.). The specification of the condenser box is relaxed, and allows of anything that is of convenient shape and ample size.

The new code allows a maximum rate of gas-flow of 40 cu. ft./hr., but stipulates that no adsorption shall be completed in less than 30 min. T. T. D.

986.* Substitution of Gasoline for Ether in Morphine Determination in Opium Dross. Ua Rasmidatta. *Thai Sci. Bull.*, October 1940, **11** (3 & 4), 129.—A new procedure, claiming several advantages over the usual Malay method, is described for the quantitative determination of the morphine content of opium and opium dross. The method comprises the substitution of gasoline for ether and the omission of lead acetate and hydrogen sulphide. The gasoline used in the process had the following specification: at 144° C. the total distillate amounted to 90% by volume. The use of gasoline results in a morphine precipitate whiter in colour than that obtained when ether is employed, and its recovery is simpler and less costly than that of ether.

The substitution of gasoline for ether is not only practical in opium dross analysis, but may be suitable for the extraction of other alkaloids which are now extracted with ether. B. M. H. T.

987.* Revised Standard Method of Test for Distillation of Liquid Asphaltic Bitumen (Tentative) I.P.T. Serial Designation C.B. 3–1941 (T), A.S.T.M. Serial Designation D. 402–36 (T). *J. Inst. Petrol.*, June 1941, **27** (212), 226.—The object of the revision undertaken by the Asphaltic Bitumen Sub-Committee of the Institute of Petroleum was to specify more accurately the procedure to be adopted at the termination of the distillation and during the pouring of the residue, it being considered that this has an effect on the consistency of the results of penetration tests subsequently carried out on the residue. According to the revised test, the residue left in the flask after distillation is allowed to cool to 300° C. before pouring. B. M. H. T.

Motor Fuels.

988.* Methane as a Motor Fuel. Anon. *Engineer*, 1941, **171** (4458), 396–397.—The potential sources of methane are discussed—namely, from coal-mines and sewage gas.

In order that methane may be used as a motor fuel, it must be compressed into cylinders, the cost of compression being given as between 2½*d.* and 3*d.* for the equivalent of 1 gall. of petrol. The total cost is estimated at 10*d.* per equivalent gallon.

It is not essential to alter a petrol engine to operate on methane, but, in order to take advantage of the very high octane number, the compression ratio should be increased to about 15 : 1. The power output is thereby increased by approximately 50%.

Against the advantages of a gaseous fuel for a motor vehicle is the big disadvantage of the extra weight of the storage cylinders, and in some cases it may be considered preferable to convert methane into a liquid product. The various processes for achieving this are briefly described. J. G. W.

989. Liquefied Gas as Engine Fuel. Anon. *Gas and Oil Power*, April 1941, No. 427, p. 77.—An article discussing in general terms the advantages and disadvantages of substituting for all imported petrol indigenous gas fuels, in particular methane. It is argued that a fundamental condition is that the gas must be in a liquefied form, three reasons being given which would cause failure in any attempt to market fuel in a gaseous form—viz., the small mileage per charge, the weight and cost of containers suitable to storage at high pressure, and the cost of compressor plants. Ordinary town gas suffers from the serious disadvantage that when a low enough temperature has been reached to liquefy the hydrogen, other components, such as methane and ethylene, would be frozen solid, and hence would block pipes, valves, and other equipment. Figures are quoted showing the respective advantages as I.C. engine fuels of methane, of ethane, of propane, and of butane over petrol; and the opinion is expressed that it should not be above the capacity of modern industry by means of synthesis and pyrolysis to produce from coal whichever of these hydrocarbons is selected instead of ordinary town gas. J. C.

990.* Octane-Rating Trend Continues Upward. W. T. Ziegenhain. *Oil Gas J.*, 13.2.41, **39** (40), 22–23.—A survey of American motor-fuel quality for the present year, with a tabular comparison of octane ratings, distillation ranges, and vapour pressures for the three standard grades for each year since 1930. Differences in

distillation range between the gasolines of to-day and those of 10 years ago are illustrated graphically. The results show that octane ratings are still increasing, the present figures being 80 for the premium grade, 74 for the regular grade, and 63 for the third grade. Distillation curves have become more uniform and smoother. A note is added on the necessity of production by processes such as cracking, reforming, polymerization, and alkylation, in order to obtain these high-octane rating gasolines.
J. C.

Gas, Diesel, and Fuel Oil.

991.* Cetane Number and Chemical Composition. T. Y. Ju and C. E. Wood. *Oil Gas J.*, 9.1.41, **39** (35), 41–46.—The introductory part of the paper is devoted to a useful recapitulation of the existing knowledge on the combustion of oil in compression-ignition engines. The four phases in the mechanism of combustion are described—viz., (*a*) delay period, (*b*) rapid uncontrolled combustion, (*c*) controlled combustion, (*d*) after burning. Diesel knock and rough running, the ignition quality of fuels, the cetene and the cetane scales, together with the current methods of engine testing of diesel fuels, are all lucidly discussed. Although none of the methods of engine testing developed since 1931 has been standardized, the methods of the ignition-lag test and the throttling test are the tentative standards of the I.P.

The actual research consisted in the determination of the cetane numbers of certain pure hydrocarbons. Alkylated benzenes were considered to have properties intermediate between aromatics and paraffins, and were selected for the investigation. The hydrocarbons were prepared by the reduction of the corresponding alkyl aryl ketones. It was shown that the cetane number of the normal alkylbenzenes increases with increasing number of carbon atoms in the side-chain, owing to a decrease of aromatic simultaneously with an increase of paraffinic character. Amylbenzene is predominately aromatic, whilst *n*-hexylbenzene has properties midway between aromatics and paraffins. In a second part to the investigation the ignition properties were determined of biphenyl, diphenylmethane, and dibenzyl. The anomaly by which the most aromatic compound of these, biphenyl, has the highest cetane number is considered to be related to various factors, such as thermal stability, mechanism of combustion, and molecular configuration. The cetane numbers and other physical properties of bi*cyclo*hexyl and *m*-di*iso*propyl benzene were also determined. J. C.

992. Patents on Gas, Diesel, and Fuel Oil. M. A. Dietrich. U.S.P. 2,243,198, 27.5.41. Appl. 28.1.39. A process for decreasing the pour-point of a hydrocarbon fuel oil. A small amount of a hydrogenated castor-oil derivative is added to the oil. The compound is produced by the reaction of castor oil with an alcohol, aldehyde, *iso*cyanate, or *iso*thiocyanate, and having a softening point of 70°–160° F. It is used in proportions of from 0·1% to about 2%.

F. Martin, O. Roelen, and P. Schaller. U.S.P. 2,243,760, 27.5.41. Appl. 4.3.37. Fuel oil for diesel engines. Carbon monoxide is catalytically reduced giving hydrocarbons of B.P. 200–320° C.
H. B. M.

Lubricants and Lubrication.

993.* Heavy-Duty Lubricating Oils as Measured by Engine Tests. H. C. Mougey. *Oil Gas J.*, 1.5.41, **39** (51), 38.—A general discussion on laboratory engine tests of lubricating oils is presented. It is argued that at the present time the oil is as much a part of the engine as the pistons, valves, etc., and that to-day one of the principal causes of failure in an engine is the effect of lubricating-oil decomposition products on the other engine parts. While the conventional laboratory tests are useful as "identification" tests, experience has shown that only actual engine tests will predict the performance of oils under service conditions. The operating conditions of several engine tests are quoted—viz., the Caterpillar, the Detroit, and the Chevrolet tests—and it is suggested that the Chevrolet test is worthy of development for measuring oxidation resistance, and the Caterpillar test for assessing detergent power. The necessity for correlation work by various laboratories is emphasized, and it is considered that standardized engine tests will be evolved by which it will be possible to

(*a*) evaluate oils, (*b*) select oils for different engine and operating conditions, (*c*) develop better oils, (*d*) increase the life and output of engines. J. C.

994.* Modern Trends in Lubrication. W. H. Oldacre. *Oil Gas J.*, 17.4.41, **39** (49), 54.—The modern tendency in lubricating oils is towards the use of additives, the first of which were fatty oils used in steam cylinder and marine oils. There have now been developed a host of dopes for every conceivable purpose, some of which—*e.g.*, pour-point depressants, viscosity index improvers—are in ever-increasing use.

Recently oxidation inhibitors have been engaging attention, since heavily loaded I.C. engines have stressed to the limit the stability of lubricating oils. Deterioration of the oil has led to the corrosion of the new type bearing metals, whilst ring-sticking and lacquer formation have raised fresh problems. To deal with the latter troubles, a new class-detergency additives has arisen. These keep the deteriorated oil products in solution and prevent them from settling out in places where they might cause difficulties. A great many compounds have been used to increase the detergency of oils, including fatty oils, metallic soaps, chlorinated soaps, etc.

Bearing troubles have not been so successfully dealt with as yet, since increased loads and temperatures tend to accelerate the formation of acidic bodies by the oil.

Some sulphur-containing compounds have proved to be effective in inhibiting acid formation, and it has been stated that their action is due to (i) the precipitation of metallic accelerators, (ii) the formation of a metallic sulphide film which affords protection from corrosion.

The author concludes that serious attention should be given to lowering oil temperatures if these troubles are to be overcome. D. L. S.

995. Patents on Lubricants and Lubrication. N.V. de Bataafsche Petroleum Maatschappij. E.P. 536,827, 28.5.41. Appl. 27.11.39. The addition of small quantities of the salts of polyvalent metals and aromatic mono-carboxylic acids, to mineral or other lubricating oils, to avoid the trouble of sticking piston-rings. The above salts, unlike those of polyvalent metals and aliphatic acids, do not break down at the temperatures of operation, nor do they corrode lead-bronze or cadmium alloy bearings. They do not settle out, nor do they cause gelatinization of the lubricant. Some of these salts are moderately soluble in oil—*e.g.*, the zinc salt of *p.-tert.*-butylbenzoic acid is soluble to the extent of 1·5% in Venezuelan lubricating-oil distillate refined with furfural.

Acheson Industries, Inc. E.P. 536,872, 30.5.41. Appl. 31.8.39. Lubricants for bearings which are subject to high temperatures have consisted of graphite or mica suspended in a light petroleum or other volatile solvent, which serves to convey the material to the bearing, then evaporates. It is proposed to use a colloidal graphite, reduced to the colloidal condition in the presence of a polymerized *iso*butylene of molecular weight approximately 7000, suspended in such a solvent, in the presence of a colloid stabilizer. This preparation does not separate out on standing, nor does the graphite flocculate.

Celec. Corp., Ltd. E.P. 537,082, 9.6.41. Appl. 11.12.39. Lubricating oils may be reconditioned and clarified by adding to them a gel obtained by boiling certain plant material—*e.g.*, sisal—in a solution of sodium carbonate. After thorough incorporation in the oil, the gel is flocculated by addition of acid or of a copper or nickel salt in solution. After maintaining at 60° C. for ½ hr., the mixture is filtered. The result is a clean, clear oil of improved viscosity, with no moisture content or acidity.

Armour & Co. E.P. 537,122, 10.6.41. Appl. 7.12.39. The use, as a pour-point depressor, in a lubricating oil or grease, of a substance obtained by reacting a coumarone with a fatty acid chloride having at least 12 carbon atoms—*e.g.*, stearyl chloride—in the presence of an acetylating catalyst. The acylated coumarone is added in the proportion of 0·1–3%, and it is claimed that running friction is reduced by use of these oils.

R. E. Burk. U.S.P. 2,242,174, 13.5.41. Appl. 16.8.38. A lubricating compound comprising an oil of lubricating viscosity having an incorporated sulphur compound

and a lead salt the acid component of which results from oxidation of petroleum hydrocarbons of 350–550° F. b.pt.

C. M. Loane and B. H. Shoemaker. U.S.P. 2,242,400, 20.5.41. Appl. 13.9.37. A lubricant containing from 0·01 to 5% of tetrachloropropyl silicate, $Si(OC_3H_4Cl)_4$.

K. Frolick. U.S.P. 2,243,420, 27.5.41. Appl. 11.3.39. A small amount of a synthetic ester (b.pt. above 150° C.) of acids formed by the low-temperature oxidation of paraffin wax, is added to a viscous hydrocarbon oil.

J. M. Musselman. U.S.P. 2,243,485, 27.5.41. Appl. 11.3.39. A mineral oil containing a small amount of an arylethyleneamine compound from the group consisting of phenyl and tolyl derivative, with a fatty acid of at least 10 carbon atoms and a naphthenic acid.

B. H. Lincoln and A. Henriksen. U.S.P. 2,244,886, 27.5.41. Appl. 28.8.39. An improved lubricating oil. To a mineral oil is added a small proportion of a sulphur-chloride treated condensation product of a halogenated paraffin and an aromatic hydrocarbon. H. B. M.

Asphalt and Bitumen.

996. Asphalts from Some Wyoming and Other Asphalt-Bearing Crude Oils. K. E. Stanfield. *U.S. Bur. Mines, Report of Investigations*, No. 3568, May 1941.—This report deals with the preparation and properties of several straight-run asphalts of different consistency derived from crude oils of Arkansas, California, Mexico, and Wyoming. It describes the apparatus, technique, and oils actually employed in preparing the asphalts, the procedure being to reduce the crude oils in two steps: (*a*) topping by distillation at atmospheric pressure, and (*b*) removing heavy distillate or lubricating-oil fractions by distillation at decreased pressure.

The test methods employed on the prepared asphalts included determination of bitumen and ash content, solubility in carbon tetrachloride, carbon residue, ductility, flash- and fire-points, loss on heating, penetration, softening-point, specific gravity, sulphur, viscosity, and the Oliensis spot test, much used in America to measure heterogeneity of asphalts.

Full experimental results are given, including distillation temperatures and pressures obtained while preparing the asphalts; also yield and properties of the prepared asphalts, and estimated yield and properties of the 100-penetration asphalts from the various samples investigated, are discussed in detail.

In the third section of the report, temperature susceptibilities of the prepared asphalts are estimated by calculating values for eleven temperature–susceptibility factors hitherto proposed by different investigators. The values obtained for these factors showed different degrees of deviation with change in penetration for asphalts from the same crude oil, and the conclusion is reached that values for viscosity temperature susceptibility coefficient show least deviation with penetration change, whilst values for susceptibility index and fluidity show greatest deviation with penetration change.

It is pointed out that the work involved in these investigations did not include performance or service tests, so that conclusions could not be safely reached as to the suitability of the prepared asphalts for specific purposes; but on chemical and physical grounds, asphalts from Wyoming crudes compare favourably with those from Arkansas, California, and Mexico, and should find similar commercial applications to those for which the latter sources are employed. A bibliography is appended. H. B. M.

997. Asphalt and Related Bitumens. A. H. Redfield. *U.S. Bur. Mines, Minerals Yearbook*, 1940. This report describes the production of asphalt of all kinds in the United States for 1939, when the refineries had to increase output by 10% during that year to meet increases in domestic demands and, to a lesser extent, foreign requirements; they, however, accounted for only 4% of the total output. It is interesting to note that America imports refined asphalt as well as natural asphalt: the amounts increased during this period, being 47,261 and 26,586 short tons, respectively, the former comprising principally Lake asphalt. H. B. M.

998. Significance of Various Methods of Tests Used on Asphaltic Paving Materials. *Technical Advisory Committee, the Asphalt Institute, Research Series*, No. 6, 1941.—This bulletin interprets the various tests applied to asphalt in terms of practice. It stresses the value of truly representative samples. Specific gravity establishes relationship between weight and volume for shipping and costing purposes; in conjunction with other tests it is used to determine void content in asphalt mixtures, also as a measure of uniformity. Ductility is essentially extensibility of asphalt under specified conditions, its presence or absence being more important than the actual degree determined. Softening point is an indirect measure of consistency; it is valuable as a basis of selection of asphalt for a particular purpose; used in conjunction with penetration, it indicates susceptibility. Penetration is the basis on which all solid and semi-solid asphalts are classified, and is a measure of consistency at standard temperature and of susceptibility when other temperatures are employed. Flash-point is indicative of volatility and a guide to the safety temperature when using any particular grade of asphalt; fire-point is of little significance. Solubility in CS_2 and CCl_4 is a quantitative test for bitumen content, generally required by specification. Asphaltene is determined largely for identification purposes; if absent, it denotes lack of binding properties. The Oliensis spot test is mostly used for identifying asphalts manufactured by cracking process; it is not applicable to native asphalts. Distillation is the most useful volatilization test, and results indicate performance and suitability for specific purposes. Loss on heating is regarded as an accelerated volatilization test, giving an indication of volatility under specified conditions. Other tests dealt with include paraffin content, fixed carbon, and ash. H. B. M.

999. Direct Method of Determining Thickness of Asphalt Pavement with Reference to Subgrade Support. P. Hubbard and F. C. Field. *The Asphalt Institute, Research Series*, No. 7, 1941.—The method given in this paper is based on actual tests and observations on behaviour of asphalt pavements laid direct on prepared soils; it does not involve theorizing as to probable behaviour. The unit load-supporting capacity of a soil varies with the area over which such unit load is distributed. The basis of rating load-supporting capacity is "the unit load applied to a circular bearing area of 130 sq. in. required to produce a deflection of 0·5 in." Tests were made on compacted soil samples in a metal box 2 ft. square and 1 ft. deep, using a Southwark–Tate–Emery Universal Testing Machine of 60,000 lb. capacity, equipped with autographic stress–strain recorder. Normal results on the soils alone were obtained when the loaded area did not exceed 58 sq. in.—*i.e.*, that of the tyre contact area of a light truck capable of carrying a 4000-lb. wheel-load. By using three circular load-bearing areas of known diameter, perimeter-area ratios are established which, plotted against loads in lb./sq. in., give the rating of the particular soil under test. Sections of asphalt are then laid on the soil and tested in the same manner; similar load-deflection curves are thus obtained to those developed by the soil alone, from which it is concluded "that under concentrated loading an asphalt pavement resting upon a plastic soil subgrade develops the same type of reaction that governs the behaviour of a soil alone." It is claimed that this method is of great value to the highway engineer; it enables him to determine, among other things, the proper thickness of asphalt required for any rated supporting value of a given soil; relative efficiency of soil-stabilization methods with reference to their load-supporting value; and how thick a stabilized soil should be constructed to support adequately an asphalt pavement of specified thickness. H. B. M.

1000. 1. The Washington National Airport. R. S. Thomas. **2. Choice of Surfacing Types for Airports.** H. H. Houk. *The Asphalt Institute, Construction Series*, No. 54, 1941.—This publication, with a foreword by B. E. Gray, chief engineer, Asphalt Institute, gives an informative account of layout and construction of asphalt runways for municipal airports. The first paper describes location, design, hydraulic fill and grading, paving, and buildings. The second paper deals specifically with surfacing types, the tendency being towards thinner layers of asphalt than in the case of highways, but thicker layers of stabilized soil. Built-in skid-resistance is an important factor, and any design of top dressings and seal coats must bear this in mind; premixed materials are favoured in this connection. Airport surfaces must be smooth

and even to prevent shock, impact damage, etc. Some degree of settlement is inevitable with time, but this is easily corrected by application of "maintenance courses"—*i.e.*, specially designed bituminous materials which fill up any unevenness in the runway surface. H. B. M.

1001. Patents on Asphalt and Bitumen. L. V. Gourlay. E.P. 536,564, 20.5.41. Appl. 26.4.40. Treatment of stone chips for use on roads, by heating a non-absorbent stone, then coating with 1–2% of a primer of 60% coal tar pitch and 40% creosote oil, then, with or without addition of a filler, treating the coated stone with 4–5% of a molten bituminous binder. Finally, 2–5% absorptive sand may be added.

Emile L. Baldeschwieler. U.S.P. 2,243,409, 27.5.41. Appl. 4.9.37. To improve the adhesivity of a bituminous composition, 1–2½% of a lead-soap is added to an asphalt, and the resulting mixture is maintained at 210–350° F. for at least 5 days. H. B. M.

Special Products.

1002.* The System Nitromethane *n*-Propanol-Water. A. R. Fowler and H. Hunt. *Industr. Engng Chem.*, 1941, **33**, 90.—The ternary phase diagram of nitromethane, *n*-propanol, and water has been determined in order to find a means of separating these three components which occur together during the production of nitromethane by the nitration of natural gas. Refractive indices and densities are given for the binary and ternary mixtures. The vapour–liquid equilibria data for the binary and ternary systems are also given. The ternary mixture forms an azeotrope. A means of recovering nitromethane from the three-component system is suggested. J. W. H.

1003.* Develop Special Paraffins. Anon. *Nat. Petrol. News*, 19.2.41, **33** (8), R.50.—Two factors are accelerating research in the development of special paraffin waxes. War conditions have hampered the supply of carnauba wax, montan wax, and ozokerite, and new dewaxing processes are producing new types of wax. No satisfactory substitute for carnauba wax has yet been produced, but certain high-melting-point, microcrystalline paraffins give promise as substitutes for ozokerites. The predominating desirable characteristics are high gloss, high tensile strength at low temperature, high melting point, and hardness. Waterproof wrappings, candles, and polishes are the principal markets for wax, but many other outlets for waxes of the right properties are visualized. H. G.

1004. Patents on Special Products. E. T. Layng. U.S.P. 2,241,708, 13.5.41. Appl. 25.11.38. Treatment of hydrocarbons. Dehydrogenation of a hydrocarbon by use of a catalyst the active ingredient of which is formed by igniting chromic acetate. Preparation of aromatic hydrocarbons by treating aliphatic hydrocarbons having at least six carbon atoms per molecule with a catalyst prepared by igniting chromic acetate.

C. M. Thacker. U.S.P. 2,242,488, 20.5.41. Appl. 10.12.37. Conversion of paraffins into olefines. A catalyst of silica gel impregnated with a solution of copper tungstate, dried by hot air, and reduced with hydrogen, is used in dehydrogenating paraffins of low boiling point. H. B. M.

Detonation and Engines.

1005.* Theory of the Kadenacy System. E. W. Geyer. *Engineering*, 1941, **151** (3935), 463–464.—A mathematical treatment of the mechanism of the Kadenacy effect is given, and calculations are made from the published experimental data of Professor Davies.

The author concludes that unless the area at outlet is a considerable fraction of the cross-sectional area of the vessel the depressions obtained are negligibly small. J. G. W.

1006.* Safety Devices for Heavy-Oil Engines. Anon. *Engineering*, 1941, **151**, 497.—A safety device of simple design, made by the National Gas & Oil Engine Co., automatically cuts off the fuel supply should the lubricating-oil pressure fall below a predetermined limit. When the engine is running, the normal lubricating-oil pressure is arranged to lift a double oil-proof diaphragm, and thereby to hold open a spring-loaded mushroom-type valve connected to the suction pipe of the fuel-pump. Failure of the lubricating-oil pressure at once allows the spring-loaded valve to shut off the fuel supply. By making an adjustment of the spring loading and changing the material of the lower diaphragm, the device can be as easily used for the automatic stopping of the engine should the cooling-water supply fail.

To safeguard an engine against too high a cooling-water outlet temperature, an additional device can be used consisting of a simple fuel-valve controlled by a bellows type mercury-in-steel thermometer. E. F. C.

1007.* Evaluation of Diesel Fuels in Full-Scale Engines. Report of Co-operative Fuel Research Committee. W. G. Ainsley. *Refiner*, July 1941, **20** (7), 282. *Paper Presented before American Petroleum Institute.*—The C.F.R. Full-Scale Engine Group was organized by engine-men representing the major classifications of automotive-type diesel engines. This original group, with the co-operation of the representatives of the petroleum industry, the Government agencies, and colleges, has carried on an extensive series of tests on commercial diesel engines.

The purpose of the investigation was to determine the influence of fuel properties, such as cetane number, viscosity, volatility, and gravity on the engine performance.

In summarizing the data from these full-scale diesel-engine tests, it is realized that many of the fuel characteristics are related; and, although engine performance varies with the test values on the fuels used, it may or may not be a direct relation.

The results are given in graphs and tables with the following conclusions: (1) the ignition quality of the fuel (cetane number, A.S.T.M.) affects starting, engine smoothness, exhaust smoke, exhaust odour, and combustion-chamber deposits. (2) The volatility of the fuel (A.S.T.M. distillation) affects smoke and engine deposits. (3) The viscosity (Saybolt Universal seconds) affects smoothness and smoke. The importance of viscosity was recognized in the basic research programme as involving the consideration of ease of circulation, atomization, penetration, injection pump-plunger leakage, lubrication quality, heat content, volatility, and overall power output. The data on power output show a decrease in power with a decrease in viscosity, which may be caused in part by the effect of viscosity. (4) The gravity (A.P.I.) affects smoke, power, and fuel consumption. (5) The carbon residue on 10% bottoms (A.S.T.M.) affects smoke and combustion-chamber deposits.

The paper ends with two appendices dealing with recommendations on required diesel-fuel characteristics and with exhaust odour rating of diesel fuel, respectively. A. H. N.

1008. Annual Report of the Explosives Division, Fiscal Year 1940. W. J. Huff. *United States Bur. Mines, Report of Investigations*, 3537, November 1940.—This report contains a section on the investigation of hazards in using diesel locomotives in confined spaces, such as coal-mines. It is emphasized that the use of petrol engines in similar circumstances is unsafe and should be discouraged. With unprotected diesel engines, apart from hazards to health consequent on discharge of toxic gases, there is always a possibility of explosion when operating in an inflammable atmosphere. Recommendations include engine tests to determine the amount of air required for safe ventilation, examination of the atmosphere in which engines will operate, adjustment of quantity of air to maintain safe conditions, and frequent inspections of engines to maintain normal exhaust. The essence of these investigations is to create conditions under which complete combustion of diesel fuel is obtained. H. B. M.

1009.* Calibration of Tetraethyl Lead in Standard Reference Fuel C 12 by C.F.R. Motor Method. Report of the Institute of Petroleum Knock Rating of Aircraft Fuels Panel Sub-Committee. *J. Inst. Petrol.*, June 1941, **27** (212), 230.—A calibration curve for T.E.L. in C 12 reference fuel has been prepared. Primary reference

fuels were not employed, as two accepted sub-reference fuel calibrations—viz. T.E.L. in C 11 and F 3 in C 12—were available for cross checks. Four concentrations of T.E.L. in C 12 were rated in twelve C.F.R. engines, owned by seven laboratories, thus providing twenty-four ratings for each point. B. M. H. T.

1010. Patents on Detonations and Engines. Mathias Pier and Gerhard Free. U.S.P. 2,242,321, 20.5.41. Appl. 24.8.39. A process for the production of non-knocking motor fuels by catalytic cracking of hydrocarbons obtained from CO + H_2 reaction, mixed with a paraffin-base petroleum.

W. L. Benedict and J. E. Ahlberg. U.S.P. 2,242,504, 20.5.41. Appl. 29.4.39. Catalytic production of anti-knock gasoline from hydrocarbon oil. Hydrocarbon oil is extracted with a selective solvent. The result is separated into raffinate and extract. The raffinate is dehydrogenated, the extract is hydrogenated, and then both are catalytically cracked. Gasoline is obtained, and also a gas, which is returned to the hydrogenating step. H. B. M.

Economics and Statistics.

1011.* Oil Situation in Russia. Anon. *Engineer*, 1941, **CLXXI**, 413-414.—The total production of crude oil in Russia during 1939 was 30 million tons. Only a slight increase in output is estimated for 1940; this is ascribed to lack of modern drilling equipment with which to develop many potential oil-producing areas.

The author discusses the effective value of Russian oil assets to the German war machine, having in view the inevitable destruction by the Russians of all oil stocks, refinery, and oil-well equipment which threatens to fall into German hands, also the possibilities and limitations of alternative methods of oil transport from each of the main oil-bearing areas should Germany be forced to attempt transport of crude oil to European refineries. E. F. C.

1012.* Natural Gasoline Plants in the United States. Anon. *Oil Gas J.*, 24.4.41, **39** (50), 92.—A list of natural-gas plants is given, by States. The information tabulated is: Company and Plant Address; Field Location; Type of Plant (Absorption, Charcoal, Compression, Vapour Rectification or Compression and Absorption); Daily Capacity (in gallons). T. T. D.

1013.* Validity of Competition in a Natural Resource Industry. J. D. Gill. *Petrol. Tech.*, May 1941, A.I.M.M.E. Tech. Pub. No. 1324, 1–5.—It is assumed that the rate and extent of the economic development of the U.S.A. demonstrate the validity of competition in the non-natural resource industries. There appears to be no condition within the petroleum industry which invalidates the principle of competition as applied to it. Various benefits are pointed out which have been conferred on the oil industry by competition. Whilst in looking backwards weaknesses and sources of waste can be seen, it is doubtful whether they could have been foreseen and prevented under non-competitive development, and whether problems would have been tackled so well and resources discovered so rapidly in the absence of competition. Having regard to the conditions of occurrence of oil, it is not unreasonable to expect some waste.

Competition should continue to keep the petroleum industry virile and progressive in meeting the requirements of future generations for the kind of products natural to it. The affairs of the industry should be considered carefully in relation to the whole economy of the country. G. D. H.

BOOK REVIEW.

Catalysis—Inorganic and Organic. By Sophia Berkman, Jacque Morrell, and Gustav Egloff. Pp. 1130. Reinhold Publishing Corporation, New York, U.S.A. 1940. $18.

This, the latest contribution from the Research Dept. of Universal Oil Products Co., Chicago, is entirely worthy of the reputation of a well-known laboratory and the renown of the authors.

In a general introduction attention is directed to the impossibility of formulating a complete theory of the mechanism of catalysis, but the hope is expressed that a systematic study of the multiplicity of experimental results here gathered together for the first time will help to resolve the complexity of the phenomena associated with surface chemistry, assist in simplifying and facilitating a critical examination of the available facts, and furthermore lead the future investigator towards justified generalizations.

In the early chapters of the monograph are discussed the factors that constitute the phenomenon of catalysis in general, such as the kinetics of intermediate reactions, the energy factor, resonance, electric and magnetic properties of catalysts, and the application of the electronic theory. Adsorption, homogeneous and heterogeneous catalysis, catalytic activity, activation and reactivation, inhibitors, promotors, poisons, and carriers are dealt with in a comprehensive manner.

After the general introduction there follows a very extensive tabular survey of the catalysts appropriate to various types of reaction: inorganic syntheses (*e.g.*, ammonia), organic syntheses (*e.g.*, methanol, and its homologues, aldehydes, acids, ketones, amines, and nitriles), synthetic processes of industrial importance (*e.g.*, lubricants from simple olefines, anthraquinone, esters, and ethers).

A variety of reactions involving catalysis is next summarized. Hydration (*e.g.*, of ethylene); dehydration (*e.g.*, of alcohols, glycols, acids, aldehydes, and ketones); reduction (*e.g.*, of carbon oxides); hydrogenation (*e.g.*, of di*iso*butylene, aromatic hydrocarbons, nitro-derivatives, and fatty oils); destructive hydrogenation of coal, tar-oils, and petroleum fractions; dehydrogenation (*e.g.*, of paraffins, *cyclo*-paraffins, alcohols); halogenation (*e.g.*, chlorination of paraffins, unsaturated and aromatic hydrocarbons, acids, alcohols, and ethers); alkanation; condensation; the application of boron halides and aluminium chloride and phosphates to the condensation of *e.g.*, ethylene with other hydrocarbons, the condensation of cracked benzine with olefines, of alcohols with olefines, of acetylene to vinyl esters, of acetylene to acetaldehyde, and of olefines with aromatic hydrocarbons; polymerization, covering the building up of complexes, from a large number of unsaturated hydrocarbons, the ketenes, mono- and di-olefines, styrene, vinyl compounds, and the like, and finally catalytic isomerization and cyclization.

Naturally of special interest to members of the Institute of Petroleum is the chapter entitled "Catalysis in the Petroleum Industry."

At the moment the chief concern of the oil industry lies in the production of high-octane fuel for the road and the air, together with the specialized development of high-efficiency lubricants, but, without doubt, in the future individual synthetic entities—"chemical bricks"—will more and more come into the picture. Benzene and its homologues mono- and di-olefines, acetylene, and the like, utilized in the manufacture of explosives, plastics, resins, and solvents, will assume great importance. The incidence of cracking has led to the doubling of the motor-spirit yield from crude, and the annual 400,000,000,000 cu. ft. of cracked gas will eventually be pressed into the service of the new synthetic chemistry of petroleum. Even now, on the very threshold of this startling innovation, can be seen the appearance in commercial quantities of alcohols, glycols, ether, esters, ketones, amines, chloro- and nitro-derivatives, aldehydes, lubricants, resins, and rubber.

The first section in this well-written and inspiring chapter is concerned with the production of high-duty motor spirits.

Pyrolysis, catalytic and acid polymerization, hydrogenation, alkanation, isomerization, catalytic cracking and reforming, dehydrogenation are all dealt with authentically and at considerable length.

There follows a description of the various processes concerned with the hydrogenation of coal, tars, carbon monoxide, and oil. The whole range of these syntheses is clearly set out in two very useful tables on pp. 1048, 1049. Leading on from gasoline there is developed the treatment of individual hydrocarbons and their products. Amongst these are described catalytic cyclization and aromatization; polymer lubricants from (*e.g.*, *iso*butylene); resins and plastics from acetylene and ethylene and other olefines, butadiene, phenols, styrene, vinyl, and acrylic compounds.

Naturally synthetic rubber takes an important place in these developments. Starting-out materials, such as butadiene, isoprene, dimethyl butadiene, chloroprene, styrene, and acrylic nitrile are indicated and mention is made of the Buna rubbers, Perbunan, Neoprene, Koroseal, Thiokol, and Vistanex.

Again, useful tables are given (pp. 1062, 1063) illustrating the derivatives of aromatics, resins (phenolic, thermoplastic, and vinyl), and artificial rubbers.

A short section on anti-oxidants and catalytic refining processes such as the Gray clay treating plant, desulphurization over bauxite, and sweetening by lead and copper compounds, completes the book.

There is an admirable subject and author index extending over forty-one pages. The volume is admirably printed and illustrated. It is unnecessary to add that it should and doubtless will find a place in every laboratory of industries in which catalysis is employed as well as being a valuable reference book for the general chemical practitioner.

A. E. DUNSTAN.

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Geology and Development.

1014.* Micropalæontology, Past and Present. C. Cronels. *Bull. Amer. Assoc. Petrol. Geol.*, July 1941, **25**, 1208–1255.—The author traces the rise of interest in microscopic fossils from the period when Leeuwenhock's development of the forerunner of the microscope made possible their detailed study, through the several centuries of sporadic investigation, mainly by individual scientists, in interest of pure research, to the time when micropalæontology as a utilitarian science was commenced some twenty-five years ago. He also traces the development of the science and the progressive multiplication of the micropalæontologic groups studied.

The origin and growth of the science as a subject in university curricula are reviewed and suggestions made for future expansion and for improved training in this special field. Brief consideration is also given to the academic background prospective palæontologists should acquire in order to best serve the science as well as the organization which purchases their services.

The future of the science is also analysed, and suggestions are given for enlarging the scope and significance of the field, and thus enhancing its commercial significance. Illustrations of unusual micropalæontologic objects to be expected in crude oils are given, together with a bibliography of the various publications available. R. J. W.

1015.* Estimation by Volumetric Methods of Recoverable Oil and Gas from Sands. J. F. Dodge, H. C. Pyle, and E. G. Trostel. *Bull. Amer. Assoc. Petrol. Geol.*, July 1941, **25**, 1302–1326.—Practical accuracy in volumetric estimates of oil and gas reserve is dependent both on the accuracy and completeness of the data available and on the skill and resourcefulness of the engineer or geologist in analysing and visualizing the reservoir conditions and fitting together the fragmentary data into a

compatible whole, recognizing similarities with and differences from other fields within his experience, as well as the practical limitations of the factors involved, their relative importance and relative weight. With the practical disappearance of unrestricted production in American oil-fields the utility of the once universally employed decline-curve methods for estimating reserves has, in a large measure, been destroyed. The author discusses the involving factors and the need for their modification. Recovery factors for oils are distinguished from those for gases for co-occurring and produced oil and gas mixtures. R. J. W.

1016.* Thrust Faulting and Coarse Clastics in Temblor Range, California. F. S. Hudson and G. H. White. *Bull. Amer. Assoc. Petrol. Geol.*, July 1941, **25**, 1327–1342.—The Temblor Range, the most south-easterly of the individual ranges forming the Coast Range, extends from Polonio Pass (west of Lost Hills oil-field) south-easterly to the vicinity of Maricopa, where it merges with the foothills of the western end of the east–west trending San Emigdio Range. The San Andreas Rift zone may be said to mark the south-western edge of the Temblor Range, and on its opposite side is the San Joaquin Valley, into which the range sends south-east trending spurs, such as Elk Hills and Buena Vista Hills. The range consists of two parts, arranged "en échelon," the northern one lying north-east of, and extending south-east of, the northern end of the southern part. The natural boundary between the two parts appears to be marked by an oblique-trending fault extending along the south-western side of Little Santa Maria Valley—4 miles west of McKittrick—and thence N. 60° W. across the crest of the range. The paper deals with the southern part of the range, which is essentially anticlinal and, save for certain pre-Cretaceous crystalline rocks, the oldest rocks exposed in it being Oligocene and a discussion of certain of the formations of the south Temblor Range, is formulated rather than a stratigraphic or palæontologic study. An index map is given indicating the geologic area discussed, together with sectional diagrams with references to various publications dealing with the area under discussion. R. J. W.

1017.* Seismic Velocity Variations in San Joaquin Valley, California. W. S. Olson. *Bull. Amer. Assoc. Petrol. Geol.*, July 1941, **25**, 1343–1362.—Velocities, in some form, enter into all seismic calculations, and when the precise distribution of velocities is known, it is possible to solve with a similar degree of accuracy the problems of finding the exact locations and slopes of any reflecting horizons.

The author defines the various types of velocities, velocity being definitely a function of depth, although the precise manner in which depth and associated factors influence the elastic constants of rocks is not known, but in none of the wells has a negative coefficient of increase with depth been found when all observations are included. The velocity decreases with depth only for limited distances, and is a function of geographical location. Velocity data have been obtained in approximately eighty wells in the San Joaquin Valley, and the analysis of these has revealed the existence of rapid lateral changes in velocity, the causes of which are discussed, also their effect on seismic-reflection mapping. Some methods for correcting reflection-survey data are considered. R. J. W.

1018.* Geology of Eola Oil-field, Avoyelles Parish, Louisiana. F. W. Bates. *Bull. Amer. Assoc. Petrol. Geol.*, July 1941, **25**, 1363–1395.—Eola, located in the Louisiana Gulf Coast area, in the south central part of the State, was discovered in January 1939, the location of the structure being attributed solely to geophysics. Principal production is secured from sands at top of Sabine Wilcox of the lower Eocene at a depth of about 8500 ft.; commercial oil-sands have been logged on some wells in the Cockfield and Sparta. Some ninety oil-wells have been completed from the Wilcox and three from the Cockfield; twelve dry holes have been drilled on and adjacent to the field. Eola was the first field in the area to produce oil in commercial quantities from the Sabine Wilcox.

Structurally the field appears to be a large nose extending south-east from the Cheneyville salt dome, securing its north-western closure from a very complex system of normal faults. A total relief of about 400 ft. on top of the Wilcox has been established

by the drill with a maximum elevation of 300 ft. of the producing sand above its water-level. Up to December 1940 the field has produced more than 4½ million barrels of oil, 43° A.P.I.; whilst probable ultimate recovery is more than 60 million barrels thus indicating the field to be one of the major petroleum reserves in the area.

R. J. W.

1019.* Complex Structure of Cement Field Poses many Problems. R. Ingram. *Oil Gas J.*, 10.7.41, **40** (9), 23.—Development at Cement began in 1917, since when there have been several cycles of activity. More than 20 million barrels of oil have been recovered, and a total of twice that amount is expected. There are two domes on a north-west–south-east anticline outlined in Permian beds.

In locating wells at Cement considerable preliminary work is necessary because of the steep dips, probable faulting, lenticular sands, and truncation of the Pennsylvanian at the top of the structure. Thus, the Rowe sand production was only in a semi-circular strip. In all there are about twenty pay sands, but a well often produces from sands not found in its neighbours. This behaviour is explained by some as due to a main fault parallel to the axis of the structure with minor faulting, and by others as due to a plane of steep crumpling rather than a fault. G. D. H.

1020.* Well Logs and Field Data of Active Oil Areas—West Texas. Anon. *Oil Gas J.*, 10.7.41, **40** (9), 50.—The first development was in 1923, when two pays were opened at Big Lake, the upper one in the Permian Big lime at 2400 ft. A decline in production in 1928 led to a deep test which found a show in the Ordovician at 8520 ft. The latter gave more than 2000 brl. of oil and 20,000,000 cu. ft. of gas/day. Two other wells were small, but a fourth gave 7000 brl. of oil and 60,000,000 cu. ft. of gas.

By the end of 1927 a number of major fields had been opened in the Permian lime—Hendrick, Church-Fields and McElroy, McCamey, Yates and Chalk-Settles—and in 1928 these gave 120,651,900 brl. of oil. Up to 1934 a number of Ordovician failures had been recorded in several pools, and in 1935 a well went to 12,786 ft. without any good shows in the Ordovician. However, twelve producers have been brought in the Ordovician at Sand Hills, where the formation is considerably higher than was expected. In 1940 three additional deep pools were found, two producing from the Ellenburger and one from a Silurian lime.

The pre-Permian geology is not yet fully outlined, but the highs appear to coincide generally with the line of folding running south-east from Hendricks. Between this and the rise at Big Lake to the east is a deep basin filled with Permian lime and anhydrite, which carries the Ordovician out of economical prospecting depths. In the west the Devonian and Silurian flank the high on its western side, and this production may extend westward.

A generalized stratigraphical column and a series of well logs are included.

G. D. H.

1021.* Stratigraphic Traps Renew Interest in Western Kansas. Anon. *Oil Gas J.*, 17.7.41, **40** (10), 18.—Oil has been found in a Viola lime stratigraphic trap on the south-eastern flank of the Central Kansas uplift. The well is 5 ml. north of Sylvia, and encountered the Viola at a depth of 3773 ft. The structural position of the Viola lime is similar to that in the Zenith pool 6 ml. to the south-west, where there is a truncated south-plunging terrace. The Zenith field has yielded 4,609,090 brl. of 40° oil since its discovery in September 1937. Its present daily average is 7916 brl. 258 wells are producing, about 130 of them from the Viola at an average depth of 3800 ft. About 3480 acres have been developed.

Four miles west of the Zenith structure seven wells have been completed at Stafford giving Viola oil, and one produces from the Arbuckle.

A table summarizes the developmental data for the Viola lime in Western Kansas, and a typical well log is given for the Lower Palæozoic of the Zenith field. A palæogeographical map of the south-eastern flank of the Central Kansas uplift shows the edge-line of the Viola lime and the various Viola fields. G. D. H.

1022.* Discoveries of New Reserves almost Balance Withdrawals. W. V. Howard. *Oil Gas J.*, 31.7.41, **40** (12), 38.—Discoveries and extensions during the first six months

of 1941 have estimates of 568,900,500 brl., 92,620,000 brl. less than the production for the same period. Last year the estimate for the first half was 275,688,000 brl., and for the whole year 1,371,463,000 brl., and a similar relationship is possible this year.

The discoveries and major extensions in the first six months of 1941 are listed with the proved acreage, formation and its thickness, and estimated reserves.

G. D. H.

1023.* World Production Declines as Market Losses Continue. J. P. O'Donnell. *Oil Gas J.*, 31.7.41, **40** (12), 40.—Preliminary estimates of world production for the first half of 1941 show a decline compared with the first half of 1940. The estimate is 1,052,429,000 brl., 3·5% below last year. The U.S.A. production fell by 21,000,000 to 661,521,000 brl. The U.S.S.R.'s production rose by 2% to 110,896,000 brl., whilst Venezuelan output was 102,000,000 brl., a decrease of 3%. In Venezuela three new fields were opened—Las Ollas, Santa Rosa, and Santa Barbara. The Iraq production probably declined by 70%. Egypt and Canada had marked gains.

The estimated production for the first half of 1941 is tabulated by fields, and compared with data for the same period in 1940. G. D. H.

1024.* Drilling in the United States Slightly Below Last Year. W. V. Howard. *Oil Gas J.*, 31.7.41, **40** (12), 58.—9724 oil-wells, 1251 gas-wells, and 3278 dry holes were drilled during the first half of 1941. The average initial production of the wells was less than for the same period of 1940. In Michigan and Illinois average initials are about 70% down. The eastern fields show little significant change, and of the 2183 oil-wells reported, one-half are input wells for water-flooding in the Bradford district. There was a large increase in the number of 3000-ft. wells completed for less than 100,000 cu. ft./day. In Ohio especially, the search for oil has become subsidiary to drilling for gas.

Apart from the Falls City district of the Forest City basin, there is little activity in that region. Much more attention is being paid to Western than to Eastern Nebraska. One of the main activities in Kansas has been the linking of old pools. On the flanks of the Central Kansas uplift stratigraphic traps are assuming greater importance, and the discovery of oil in a Pennsylvanian sand opens up a large, virtually untested area for prospecting.

In Oklahoma a number of Wilcox pools were found, some to the west of the Seminole district, some in the north central part of the State, and some in the south-western district. Woodbine prospecting has been revived in East Central Texas following the discovery of Hawkins. Ordovician production in West Texas is expected by some to have possibilities equal to the Permian. North Central Texas is becoming an area of deeper drilling. Ellenburger production has been found at K.M.A., Worsham, Electra, and in Cooke County. There has been a 10% decline in activity in coastal Louisiana and a 30% decline in South-west Texas.

The completions, their status, and average production are tabulated by States or districts for the first halves of 1941 and 1940. G. D. H.

1025.* Production in Mid-Continent Rises; Texas, East Decline. W. V. Howard. *Oil Gas J.*, 31.7.41, **40** (12), 60.—The U.S.A. oil production was 661,521,324 brl. during the first half of 1941, 23,194,190 brl. less than in the same period of 1940. Illinois, Texas, Oklahoma, and Michigan had a total decline of 40,167,957 brl. Production in the north-eastern States as a whole decreased by 22,995,579 brl. Increases of 20% took place in Kansas and Wyoming. Tinsley was responsible for a 220% rise in Mississippi, and Falls City development raised Nebraska's output by 940%.

Texas' decline of 4·5% was not uniformly distributed. California's production was practically unaltered, whilst the Rocky Mountain production rose by 9%. In descending order of output, the first five States are Texas, California, Oklahoma, Illinois, and Louisiana. The seventy-five largest fields are tabulated in order, and the annual production by States is given for the period 1935–40.

Brief notes are given on some of the leading fields. G. D. H.

1026.* Illinois—Benton Field Discovery Climaxes Successful Half-year. Anon. *Oil Gas J.*, 31.7.41, **40** (12), 71.—During the first six months of 1941 more fields were discovered than in any like period since the State's revival as a leading oil-producing State. Despite declines in the outputs of the leading fields, the new discoveries have maintained, and even increased, the total production. The daily production during the half-year has averaged 326,932 brl., nearly 110,000 brl./day less than a year ago.

The main activity has been in White County, most of the discoveries being along the Wabash River. The Rising Sun field has given excellent recoveries from the Tar Springs and Aux Vases sands, but the Benton pool of Franklin County is outstanding, and is now the State's largest producer. It gives 30,000 brl./day from the Tar Springs sand. The long-awaited Devonian test at Louden came in at 2500 brl./day, but almost immediately began making large volumes of water, and all subsequent wells have had water troubles.

The Illinois discoveries are listed for the first half of 1941; the half-yearly productions are tabulated by fields for the period 1939–41, and the production by months for 1941; and the completions and their status are summarized by fields for the first six months of 1941. G. D. H.

1027.* South-west Texas—Oil on Flanks of Distillate Pools Outstanding Discovery. F. L. Singleton. *Oil Gas J.*, 31.7.41, **40** (12), 73.—Although no spectacular developments took place in South-west Texas during the first half of 1941, new sand discoveries and important extensions increased the district's potentialities. Drilling operations showed a sharp decline and totalled 862 wells with 302 abandonments. On the Lower Gulf Coast prolific production was opened in down-dip sands flanking the Agua Dulce and Stratton fields. Oil was also found in deeper sands in the Lower Oligocene. At Stratton the oil is down-dip in the distillate sands. Stratton and Agua Dulce are on a single elongated anticlinal structure. An important new sand appears to have been opened at Midway, and a lower Frio sand has been brought in at Luby. Favourable showings have been logged in 10,000-ft. tests at St. Charles, McCampbell, and East Flour Bluff. Few important developments took place in the Laredo district. There was a fair amount of wildcatting on the Wilcox trend, extending along the old Jackson shore-line trend. Bee Creek and Tenney Creek were further developed in the Balcones fault-line district.

The half-yearly production is tabulated by fields for the period 1939–41, the discoveries, completions, and their status are listed for the first half of 1941, and the monthly outputs are given for the same period. G. D. H.

1028.* California—Reserves Maintained Largely by Discovery of Deeper Sands. L. P. Stockman. *Oil Gas J.*, 31.7.41, **40** (12), 81.—California's crude oil reserve was not maintained during the first six months of 1941. New discoveries have added but little to the reserves, but deeper drilling and extensions in proved fields have maintained reserves fairly well. Kettleman Hills is expected to produce 26,600 brl./acre from 16,000 acres, and it is hoped that a well, now at 12,490 ft., has proved oil below the present productive zone, the McAdams of the Upper Eocene.

Three new oil-fields and one gas-field have been discovered during the first six months of 1941. The Raisin City field is the first commercial accumulation found north of Coalinga, and it is believed to be substantial. The Oak Canyon field of the Newhall–Castaic region first showed a small heavy-oil accumulation, but a deeper discovery gave 720 brl. of oil/day with 900,000 cu. ft. of gas from a well in the Modelo at 6960 ft. It is on the northern end of the Halsey anticline. The value of the heavy oil discovery at Union Avenue, Kern County, is not yet determined. Two wells have been completed in the Vernalis gas-field of San Joaquin County. A summary is given of wells completed and of the discoveries in the first half of 1941; the monthly production is given by fields for the same period, and the half-yearly output is tabulated for the period 1939–41. G. D. H.

1029.* Louisiana Gulf Coast—Field Development Reaches Peak; Old Domes Yield Deep Pays. H. L. Singleton. *Oil Gas J.*, 31.7.41, **40** (12), 86.—Ten new fields were found in the first six months of 1941, and several million barrels of new reserves were

added by exploration around old salt domes. The new fields range 7700–10,800 ft. in depth, and multiple sands have been logged in some. Important deep-sand production has been opened on the following known salt domes: West Cote Blanche, Belle Isle, Gueydon, Venice, Potash, Welsh, Anse La Butte, and Pine Prairie. The new developments are described. New sand discoveries have also been made in the following structures which are believed to be deep-seated salt domes: South Crowley, White Lake, Kenilworth, West Lake Verret, and West Bay.

Several new fields were found in the Delta district, and include Delacroix Island and Octave Pass. Several sands have been logged in the Miocene. The Port Allen field yields oil from 9610 ft., with several shallow sands above, and the Unknown Pass field in Lake Catherine came in with 325 brl./day from a well at 9887 ft.

The new discoveries in the first half of 1941 are listed; there is a summary by fields of the status of wells drilled in the same period and the monthly production of the fields. The half-yearly production by fields is tabulated for the period 1939–41.

G. D. H.

1030.* Texas Gulf Coast—Maurbro Discovery Keeps Jackson County in Limelight. N. Williams. *Oil Gas J.*, 31.7.41, **40** (12), 92.—During the first half of 1941 eleven new fields were discovered. Drilling operations were increasing at the end of the period, after being below the previous half-year's level. Maurbro seems to be the most important discovery. Nine wells have been completed in the Frio at about 5220 ft. New sands have been found and extensions made at Lolita. There was much drilling at West Ranch, and a new sand has been opened at Ganado at 6468 ft. Two new sands have been brought in at West Ganado.

Sheridan was one of the two Wilcox fields, and before it was discovered it was thought that Wilcox production was limited to the uppermost 500 or 600 ft. Now deeper exploration has been undertaken in proved Wilcox areas. Important Cockfield production seems to have been proved at Garwood at a depth of 6104 ft.

As regards marine development, success has been achieved in the Sabine Pass field with a well in the Miocene at 4980 ft. Two Frio sand discoveries were made at Chenango and Oyster Bayou, but the former seems rather disappointing.

The half-yearly production by fields is tabulated for the period 1939–41. The new discoveries are listed for first half of 1941. The status of wells drilled and the monthly production by fields are listed for the same period. G. D. H.

1031.* Oklahoma—All Districts Add to Reserves in Half-Year of Great Activity. R. Ingram. *Oil Gas J.*, 31.7.41, **40** (12), 96.—Although only in the first stages of development Guthrie and Tecumseh Lake were producing more than 2000 brl./day at the beginning of June. Simpson production was found in the old Velma pool and at Velma, opening up a large area for prospecting in South-west Oklahoma. This area gave much new oil, with a boom at West Hewitt, deepening and new drilling at Empire, and steady drilling at Tussy, Hobart, Cement, and West Frederick.

The most important single development as regards new production was the Cumberland pool. New pools are being sought in Central Oklahoma on trends and cross-trends from the Nemaha Ridge, and one success was Guthrie with 200 acres of Wilcox production. Misener–Hunton production has been obtained by plugging back from the Wilcox at Coyle and Ramsey.

Nine new pools were opened in the Greater Seminole area in the first half of 1941. These include Tecumseh Lake, North Little River, North St. Louis, and South Maud. Prue sand output is being developed at East Stroud.

Oklahoma's discoveries and the extensions for the first half of 1941 are listed; also the status of new wells by fields and the monthly output for the same period. The half-yearly production is tabulated by fields for the period 1939–41. G. D. H.

1032.* Eastern Texas—Hawkins Responsible for Intense Prospecting Activity. R. M. Sanford. *Oil Gas J.*, 31.7.41, **40** (12), 101.—During the first half of 1941 there was general wildcatting in Eastern Texas, arising from developments at Hawkins and three new oil discoveries. The new discoveries are East Long Lake, Laneville., and a new deep oil horizon in the Willow Springs gas-field.

The Hawkins field has been proved over 3500 acres. At Willow Springs a considerable gas area has been proved in the deep Pettit lime of the Trinity, and oil has been found in the west side of the field. East Long Lake gives oil from the Woodbine, on a structure which is probably separated from the Long Lake field proper to the south-west.

The half-yearly production and the monthly production by fields are tabulated for the periods 1939–41 and January–June 1941 respectively. G. D. H.

1033.* North Central Texas—Ellenburger Production Assumes Major Importance. R. M. Sanford. *Oil Gas J.*, 31.7.41, **40** (12), 102.—Several strikes in the deep Caddo lime and conglomerate sections of the Bend series during the first half of 1941 are expected to be of major importance, but these may be surpassed by the Mississippian lime horizon. Several shallow discoveries and most of the Mississippian lime strikes are located on the mergence of the Bend Arch and the Red River Uplift. The Caddo lime strikes are on the same trend, and the Bend conglomerate discoveries are on the south flank of the Red River Uplift, where Ellenburger production was developed also, as well as on the south-west flank of the Muenster Arch.

The Mississippi lime generally lies immediately below the Bend series, and where favourably situated it is prolific, wells coming in at 1000 brl./day being common. The Ellenburger is prolific at K.M.A., and the old Electra field now gives Ellenburger oil.

Eighteen new fields or new producing horizons have been found in West Central Texas during the first half of 1941. There were six new strikes in the Noodle Creek district. Many strikes were gas—Boyston, Greynolds, Hudson, Gordon, and Kirk. There has been much wildcatting at depths of 150–5000 ft. in areas with two to twelve possible zones of production in view.

The discoveries in North and West Central Texas are listed for the first half of 1941, and the completions are tabulated by fields for the same period. The half-yearly production is given by fields for the period 1939–41, and the monthly production is given for January–June 1941. G. D. H.

1034.* North Louisiana, Arkansas, Mississippi—Wilcox Trend Play Sustained by Important Discoveries. G. Weber. *Oil Gas J.*, 31.7.41, **40** (12), 109.—In the first half of 1941 five Wilcox fields were found in North Louisiana. The new production is from thin, lenticular sands deep in the Wilcox, whereas old Wilcox fields such as Urania, Tullos, and Georgetown produced from the top of the formation. The new production is not always associated with Wilcox highs.

The Athens gas-condensate field has been limited by a failure, and at Lisbon the first Smackover production was completed in a deep gas-condensate well near the top of the structure. On the south-east side deep wells failed to get production in the Travis Peak or Cotton Valley formations.

In the early part of 1941 the two most active fields in South Arkansas were McKamie and Dorcheat, two high-pressure gas-condensate pools. A new gas-condensate field was found 5 ml. east of Dorcheat. Deep production was also obtained in the Travis Peak and Cotton Valley.

In Sharkey County, Mississippi, a wildcat gave some oil from the Eutaw, and then there was salt-water intrusion. Tinsley was extended to the south-east in the first half of 1941, and the reserves were nearly doubled by the discovery of thick Woodruff sand sections.

The new discoveries in North Louisiana and Arkansas during the first half of 1941 are listed, and the monthly production by fields in the same period is given for these two areas and Mississippi. The status of wells completed during January–June 1941 is given by fields for Mississippi, Arkansas, and North Louisiana, and the half-yearly output is tabulated for the period 1939–41. G. D. H.

1035.* Canada—North Turner Valley Development Aids Production Increase. V. Lauriston. *Oil Gas J.*, 31.7.41, **40** (12), 112.—Alberta's oil production during the first half of 1941 was 4,784,600 brl., 1,150,000 brl. more than in the same period of last year. At the end of June there were 154 oil-wells at Turner Valley, and 17 in other fields. In the first five months Turner Valley gave 23,615,227,000 cu. ft. of

gas, Viking–Kinsella 2,242,036,000 cu. ft., Medicine Hat–Redcliff 1,480,097,000 cu. ft., and Wainwright 55,993,000 cu. ft.

The most important recent feature of development at Turner Valley is the steady northward extension of production. Gas conservation has been enforced.

Early drilling in the Steveville–Princess area 120 ml. east of Calgary yielded gas in the Madison limestone, and light crude was found at the top of the Madison early in 1941. The well had a high gas/oil ratio and water troubles.

Vermillion, in East Central Alberta, is the largest producing area outside Turner Valley. Several wells give heavy crude. G. D. H.

1036.* Rocky Mountain Area—Improving Markets Permit Large Production Increase. T. R. Ingram. *Oil Gas J.*, 31.7.41, **40** (12), 114.—No major discoveries were made during the first six months of 1941 in the Rocky Mountain area. A deeper sand, the Sundance, was found to be productive, in addition to the Morrison at Wilson Creek, Colorado. The gas production from Wasatch sands was extended at Powder Wash.

Wyoming had extensions at Wertz, Mahoney, and Rock River.

A small discovery was made in Montana, north-west of Kevin–Sunburst. There was a small show in the sunburst at 1833 ft., and 20 brl./day were pumped from the Ellis–Madison contact at 2062 ft. An important extension seems to have been made to the Rimrock pool on the west side of the Kevin–Sunburst field. This also gave oil from the Ellis–Madison contact, at 2448 ft.

Gas was discovered in the top of the Madison at 3824 ft., in the Twin Rivers district, 10 ml. north-west of Cut Bank.

The Fulcher basin gas-field in North-west New Mexico was extended. Gas comes from the Picture Cliff sand at 1900 ft.

In South-west Wyoming in the first half of 1941 a number of wells were completed in the Bairoil district (Wertz, Lost Soldier, Mahoney, and East Mahoney), which gave 48% of the State's total new production, some of them probably being capable of 10,000 brl./day initially on open flow.

The new discoveries in the Rocky Mountain area are listed for the first half of 1941. The monthly production and status of wells are given by fields for the same period, and the half-yearly production is tabulated for the period 1939–41. G. D. H.

1037.* Permian Basin, Panhandle—Deep Palæozoic Trend Offers Great Reserve Possibilities. R. M. Sanford. *Oil Gas J.*, 31.7.41, **40** (12), 117.—In the past six months a deep Lower Palæozoic trend has been discovered which offers production in the southern part of the Permian Basin.

Eleven new discoveries have been made by wildcatting, the most promising being Ownby, Rhodes, Sand Hills, and O'Neil–Wright.

A deep-seated structural high extends north from northern Pecos County parallel to two established producing trends in the district. Production has been found at five points along it from the Lower Ordovician—Sand Hills, South Sand Hills, Sand Hills south extension, Abell, and Apco. Some details are given of geological conditions on this high.

The Slaughter field has been proved over 50,000 acres.

The new discoveries during the first half of 1941 are listed, the status of the wells completed is given by fields; the monthly production is tabled by fields. The half-yearly production is also tabulated for the period 1939–41. G. D. H.

1038.* Kansas—Extensions and Linking of Pools Overshadow Discoveries. R. Ingram. *Oil Gas J.*, 31.7.41, **40** (12), 123.—At the end of June the production was 241,000 brl./day. Three wildcats were being drilled along the Barton Arch towards the Nebraska State line, and the Ray pool was giving 1000 brl./day.

The main activity in the first half of 1941 was in or near developed areas. An extension to the Hall–Gurney pool was near new wells in the Greenvale pool to the south-east. West Bemis–Shutts and Burnett, Midway and Keesling, and Kraft and West Kraft were joined. Important extensions took place at Big Creek, Gorham, Trapp, Beaver, Eberhardt, Krier, East Big Creek, and Davidson.

In and around the Zenith pool, a stratigraphic trap associated with the Barton Arch,

and a pool with several pay zones, the Viola, has been most sought for recently. Seward, Shaeffer, Macksville, and Ahnert are new pools found in Stafford County.

The Louth pool in Eastern Kansas, in the Forest City basin, gives oil and gas from the Bartlesville and Burgess sands, and the second break in the Mississippian lime, all wells being about 1450 ft. deep.

In Eastern Kansas the production was raised by water-flood projects in Chautauqua, Neosho, Woodson, Montgomery, Labette, Wilson, Miami, Allen, and Elk Counties. These projects have been getting under way for several years.

At Falls City, Nebraska, in the Forest City basin, oil was found in the Lower Hunton late in June.

The oil and gas discoveries in Kansas and Nebraska during the first half of 1941 are listed. For the same region the monthly production and the status of wells are given by fields for this six-month period, and the half-yearly output by fields is tabulated for the period 1939–41. G. D. H.

1039.* Appalachian—Many Deep Tests Drilled with but Meagre Success. Anon. *Oil Gas J.*, 31.7.41, **40** (12), 131.—The first half of 1941 had 30% more completions than the same period of 1940. Tests have been made below the usual horizons, and both the Lower Devonian and Silurian have been found productive in several sections.

In Beaver County, South-west Pennsylvania, a deep test had a showing of gas in the Oriskany at 5437 ft. Another found many gas-pockets in the shale just above the Marcellus. On the Chestnut Ridge gas-wells have been completed in the Oriskany sand, and Onondaga chert. On the next large anticline to the east a showing of gas has been found in the Onondaga chert. The Bradford sand has given gas at 3507 ft. on the Fayette anticline in Franklin township.

Fair oil producers, mainly in the Clinton, were drilled in Perry, Muskingum, and Licking Counties of South-east Ohio. In Wayne township, Columbiana County, gas was found in the Oriskany at 4426 ft.

Many successful wells were drilled in the Elk–Poca Oriskany gas-field. A well deepened to the Clinton in the Elk district gave gas. A gas-well in the Poca district is now giving 5 brl. of oil/day from the Oriskany at 4975 ft. The Big lime has also given a little oil.

In Braxton and Clay Counties gas has been found in the Gordon stray and Injun sands, respectively. A number of tests in Jackson County have given gas from the Oriskany. The Gordon sand has provided several large gas-wells in the Proctor district of Wetzel County. G. D. H.

1040.* Drilling in Ontario, Canada. Anon. *Oil Gas J.*, 31.7.41, **40** (12), 133.—The activity this year has been restricted largely to efforts to develop additional gas reserves. In areas adjacent to the Brownsville field drilling failed to develop production. Five wells with an aggregate production of 452,000 cu. ft./day were drilled in Windham Township, Norfolk County, indicating possibilities of a fairly substantial field producing from the Clinton formation. Twenty small shallow producers with an aggregate open flow of 1,053,000 cu. ft./day were drilled in the Haldimand–Norfolk–Brant areas. Individual outputs ranged from 10,000 cu. ft. to 195,000 cu. ft./day. G. D. H.

1041.* Upper Pennsylvanian and New York Fields. Anon. *Oil Gas J.*, 31.7.41, **40** (12), 133.—The first half of 1941 saw the start of the decline in the prolific production of the Music Mountain pool, south of the main Bradford pool. In the northern Oriskany sand fields, which straddle the New York–Pennsylvanian line, the chief activity was a search for "pimples" passed over when the larger pools were brought in.

A well with an initial open flow of 16,200,000 cu. ft. of gas was brought in in Cameron township, Steuben County. One small gas-well was brought in in the old Medina field of Chautauqua and Wyoming Counties. In the very north-west of Pennsylvania a show of light oil was found near the top of the Trenton at 4437 ft., and there was a show of oil, gas, and salt water in a sand believed to be the St. Peter at 5181 ft. G. D. H.

1042.* Indiana, Ohio—Gas Demand, Wabash River Play Increase Drilling. Anon. *Oil Gas J.*, 31.7.41, **40** (12), 134.—193 oil-wells, 334 gas-wells, and 230 dry holes were drilled in Ohio during the first six months of 1941. Wildcatting has not been very successful, and has been mainly in the untested eastern part of the State. A test in the old Wooster pool had small oil-showings in the Trenton and St. Peter, but they did not respond to shooting and acid treatment. The Clinton was tested below the 5000-ft. level in Belmont, Harrison, Carrol, Mahoning, Tuscarawas, and Guernsey Counties. Only the Harrison County test in Washington township found a gas-pay which warrants further testing in the vicinity. Wells in the Clinton sand of the Clayton pool ranged up to 275 brl. initially. The Newark field was the most active gas-field. Completions in the Brush Creek pool of Muskingum and Morgan Counties had open-flow volumes ranging up to 10,000,000 cu. ft./day in the Clinton sand.

Indiana had no major discovery in the first six months of 1941. Continued development of the numerous sands in the Griffin field maintained the level of the State's output. Wildcatting gave two new gas-pools, one in the Devonian in Greene County, the other in the Cypress sand of Daviess County. Oil was found in the Cypress sand in the Columbia pool; the Palestine sand in Gibson County; the Salem of the Shelbourne pool; the Aux Vases sand in Posey County; the McClosky sand in Gibson County; the Cypress sand of the West Bufkin pool; the Travis in Elkhart County; the Pennsylvanian of the Vernon pool; the Devonian of the Elkhart pool; and the Cypress of the South Bufkin pool.

The status of completions in Ohio and Indiana is listed by fields. G. D. H.

1043.* Michigan—Winterfield, Reed City and Gas Play Revive Interest. O. C. Pressprich. *Oil Gas J.*, 31.7.41, **40** (12), 137.—The decline in oil production in Michigan continued during the first half of 1941. The Mount Pleasant district showed the least decline, whilst the greatest decline was in the south-west, where the Traverse is the main pay. Dundee–Monroe production has been developed in the Winterfield and Reed City fields, the latter looking like a major pool. The Walker pool was extended. Shallow development continued in Van Buren County, and the production rose from 73,060 to 92,432 brl. between January and June. In the same period Reed City production rose from 470 to 73,998 brl., and Winterfield from 1187 to 76,717 brl.

Two gas-fields were discovered in Isabella County, one being in the Michigan stray sand. Oil was discovered in the Traverse lime in Allegan, Ottawa, Kent, and Van Buren Counties, and the Beran in Bay County.

A deep test in Bay County is below 9000 ft., and has given considerable gas and distillate when blowing wild, and has not yet reached the Trenton. G. D. H.

1044.* Search for Wilcox Production Spreads in North Louisiana. G. Weber. *Oil Gas J.*, 7.8.41, **40** (13), 12.—Seven separate oil-producing areas have been opened in La Salle parish, and an eighth, in northern Avoyelles parish, is believed capable of commercial production. Two gas-pools have also been found. Most of these areas are in the initial stage of development.

Some years ago the area was explored for oil in the top of the Wilcox, and Tullos, Urania, Georgetown, and White Sulphur Springs were the fields discovered. In 1940 the Olla field demonstrated the deeper possibilities at a depth of 450 ft. from the top of the Wilcox. At Little Creek oil is found 1750 ft. below the top of the Wilcox.

In this area the Wilcox has a regional dip to the south-east. Productive sands are generally thin and lenticular, and correlation between fields is not attempted. At Olla nine sands are productive at 450–1260 ft. below the top of the Wilcox. Little Creek has at least two distinct sands. Nebo has ten sands. The sands pinch out up-dip, and are not continuous even within the fields where they are developed. The sands are erratic, rendering wildcatting hazardous, although the wells, being shallow, are not costly. Production shows no direct relationship with local highs on the top of the Wilcox.

The nature of the sands makes completion difficult. The detection of oil horizons is not easy, and in addition to electrical logging, gas detectors, coring, and cutting examination are used. Wells at Olla and Nebo make 25–30% of water. The pressures are low, and about half the wells require artificial lift.

A map is given, and a table of the recent Wilcox discoveries (name, date, depth to Wilcox, and to producing horizon, daily average production and gravity of the oil), and one of the dry wildcats drilled to the Wilcox in North Louisiana in 1940 and the first half of 1941. G. D. H.

1045.* Cuba. Anon. *Oil Gas J.*, 7.8.41, **40** (13), 22.—A new completion in the Motembo field has given 684 brl. of naphtha in a day, and the field now yields more than 1,000,000 gal. of naphtha/month. Distillate production at Motembo has risen steadily in the past few years, and is now about 455 brl./day. Last year the gasoline output was 135,715 brl. G. D. H.

1046.* Well Logs and Field Data of Active Oil Areas—South-east Wyoming. Anon. *Oil Gas J.*, 21.8.41, **40** (15), 48B.—The south-east quarter of Wyoming has given about 500,000,000 brl. of oil, more than three-quarters of Wyoming's production. Of this, 300,000,000 brl. have been obtained from Salt Creek. Early Wyoming production was discovered via seepages, but later development was based on surface structures, many of which stand out strongly. Salt Creek has ten pays from the Upper Cretaceous down to the Mississippian. Lance Creek is the second largest field, and has a series of producing horizons from the Frontier (Upper Cretaceous) down to the Minnelusa (Permian). Big Muddy produces from the Shannon, Wall Creek, and Dakota sands (Cretaceous).

In 1930 deep drilling and geophysical prospecting were begun.

Much territory with good possibilities and favourable structures remains to be prospected, and deeper drilling may reveal deeper production in known fields. Formerly a deterrent to deep drilling was the fact that in the west part of the State the Embar and Tensleep gave black oil. The deeper horizons of the Permian and Pennsylvanian are of two facies, pointing to an intervening high, with the possibility of stratigraphical traps as well as ordinary structures. G. D. H.

1047.* Two Geophysical Units Active in Brazil Coastal Areas. Anon. *Oil Wkly*, 21.7.41, **102** (7), 44.—Considerable attention is being paid to the coastal areas of Bahia and Alagoas, where there is a 20-mile-wide north-easterly trending belt of sediments. Oil has been found in beds of Triassic to Cretaceous age. In some places the sediments may be 5000 ft. thick.

There are two producers at Lobato. Two dry wells have been drilled at Camamu to 2600 and 1170 ft. A third is drilling below 1800 ft., and near Aracaju (Sergipe) a well is under way below 2600 ft.

The region of Acre, near the Peruvian border, has yet to be studied, and the same is the case with the Parana basin, which is reported to be traversed by several geoanticlines, and has sediments resembling those productive in Bolivia and Northern Argentina. Poor transport and extensive igneous flows have hitherto discouraged development. G. D. H.

1048.* Slaughter—West Texas Area Fast Approaching Record in Acreage and Activity. G. M. Wilson. *Oil Wkly*, 4.8.41, **102** (9), 35.—Between 400 and 500 wells have been completed at Slaughter, which has 1000–1500 proved locations yet to be drilled. It probably covers at least 55,000 acres. The discovery well, completed in 1936, has given 84,000 brl. of oil with very little fall in bottom-hole pressure. The main producing area runs east–west for about 14 ml., and the maximum breadth is 9 ml.

The discovery is due to sub-surface geology and seismography. Oil accumulation is governed more by stratigraphic than by structural conditions. The structure appears to be generally monoclinal, dipping at 25 ft./ml. from north to south, but there may be a nose at the eastern end. A few local highs may be present. Variations in porosity and permeability seem to govern accumulation.

Pleistocene, Cretaceous, and Triassic sands, shales, and caliche are the first 2000 ft. of beds penetrated. In the Permian are the Red Bed sands, shales, and salt, and the Big Lime limestones which are oil-bearing in a porous zone about 800 ft. below the top. The oil zone is 70–100 ft. thick, and composed of sugary dolomite. Porosity ranges

from 5 to 16%, with an average of about 12–14%, and varies from well to well. The permeability is very low, and each well has to be acidized into production.

The oil is of 32° A.P.I. gravity and very corrosive. Its 34% of straight-run gasoline is very favourable for tetraethyl lead treatment.

Some evidence seems to indicate that the field is under a combined water- and gas-drive. Present development does not indicate a well-defined gas-cap in any part of the field. The bottom-water surface appears to have a south-easterly dip.

Most operators have used a 35·4-acre spacing. Drilling, casing and completion technique and equipment are described.

Gas/oil ratios range from 100 to 1500–2000 cu. ft./brl., with the average about 800. Most wells flow, but there are 23 pumpers, mainly on the edges. Recovery estimates of 4000–9000 brl./acre have been made.

Some believe that there may be further producing zones in the Lower Permian, and perhaps as deep as the Ellenburger. G. D. H.

1049.* Cuba's Motembo Field Production Increases. Anon. *Oil Wkly*, 4.8.41, **102** (9), 68.—The Motembo field may give more than 7,000,000 gal. of oil this year, as compared with 5,700,000 gal. last year. About 200 wells are productive. G. D. H.

1050.* New Sand Indicated for El Roble; Drilling Progress. Anon. *Oil Wkly*, 4.8.41, **102** (9), 68.—A well at Roble has found an oil flow at 8500 ft., indicating a new sand. Hamaca 1, in Southern Anzoategui, was abandoned at 3472 ft. Mercedes 1, in Guarico, has been suspended, and a second well is to be drilled about 0·5 ml. to the south. G. D. H.

1051.* Palæozoic Possibilities of Northern Mississippi and Alabama. F. F. Mellen. *Oil Wkly*, 11.8.41, **102** (10), 28.—North-east Mississippi and North Alabama cannot produce oil from the Mesozoic and Tertiary, which yield fresh water, but the underlying Palæozoic has yielded more oil-shows that any other non-productive region in U.S.A. Gas only has been produced in two small fields, Fayette and Amory. In 1890 a small show was found at Goyer (Alabama) at 1509 ft. in the Ordovician.

In the east is the Sequatchie anticline, with the Knox dolomite series of Ozarkian age, and nowhere in this region has this series been drilled through to the Cambrian. Overlying are 500–800 ft. of Ordovician limestones (Stones River and Black River series). These limestones are productive in Tennessee and Kentucky, and give good shows in the present region. The Trenton series consists of silty shales and limestones, and smells of oil, but is of low permeability. The Silurian is represented over most of the area by about 100 ft. of limestones and shales. This is followed by the Chattanooga black shale, which is petroliferous. Next comes the Maury green shale. The Mississippian is 1000–1500 ft. thick, the lower part being dominantly limestone, and the upper containing limestones, sandstones, and shales with considerable lateral variation. The former part has many evidences of oil, and the latter has possible stratigraphic traps. The Pennsylvanian is represented in Alabama by the Pottsville only, and is formed chiefly of non-marine sandstones, shales, and coals. One of the sandstones gives gas at Amory. Some of the sands are very hard and impermeable.

Upper Cretaceous beds rest unconformably on the Palæozoic, overlapping on to early Ordovician beds in the north and on to progressively younger beds to the south. The asphalt deposits of this region are related to the old pre-Tuscaloosa land-surface—they are all within a few hundred feet of the base of the Tuscaloosa—show up-dip migration of the parent oil, and often indicate areas where lower horizons may merit exploration.

The area is bounded by the Sequatchie anticline on the east and the Nashville Arch to the north. The South-easterly dip increases to the South-east. The Warrior coal-basin is one of the main structural features. At the surface a number of structures of small closure have been mapped. Most of the domal or anticlinal structures of North Alabama and North-east Mississippi are faulted. Where the Palæozoic does not outcrop it is uncertain whether the Cretaceous and Eocene structures reflect deep-seated Palæozoic structures.

The St. Peter is the logical objective in the north of the Warrior basin and to the north. The Ordovician limestones seem to have possibilities, and the same is true of Mississippian horizons. Many shallow tests in the Warrior basin have had oil- and gas-showings in the Pennsylvanian.

Fifty-six Palæozoic tests have been drilled in Mississippi and 200 in North Alabama. Most have had oil- and gas-shows, and a few could have produced a little oil. Some wells found large quantities of water, pointing to good permeability.

Tables give the Palæozoic tests in North Mississippi, and the analyses of St. Peter water and of natural gas. Maps and a cross-section are included. G. D. H.

1052.* Kansas Development Surges to Record Levels. F. B. Taylor. *Oil Wkly*, 25.8.41, **102** (12), 31.—Since the beginning of the year new all-time production peaks have been set up six times, and nineteen fields have been discovered. The daily average in July was 241,950 brl. Drilling activity and average daily allowables have increased. Unlike many oil-producing provinces, there is relatively little chance of finding production at greater depths in case the normal section is barren. The Arbuckle is the chief producing horizon and also the deepest stratum which is normally productive. In a few cases the subjacent Basal sand, Reagan or Granite wash yields oil, but generally the Arbuckle rests on the basement complex. Usually the Arbuckle is at 5000 ft. or less.

In the main the major production of Kansas comes from the Arbuckle (101 fields), Kansas City–Lansing lime (70 fields), Mississippi chat (17 fields), Topeka sandy lime (15 fields) and Viola lime (12 fields). Oil is also obtained from the Bartlesville, Basal sand, Hunton, Misener, Mississippi lime, Gorham, Wilcox, Simpson, Oswald, Reagan, Conglomerate, Burgess, Pre-Cambrian, Stalnaker, Tarkio, Admire, Dodge, and Granite wash.

The Arbuckle oil has little gas, and so requires pumping, but flowing conditions obtain in the Kansas City–Lansing, Mississippi chat, and Viola lime.

Exploration is extending out into the Dodge City basin. Half a dozen fields are producing, and fair shows have been frequent in wildcats. Dead oil has been found in the Salina basin, but no production commercially. Shallow gas has been found in North-west Kansas.

Repressuring and water-flooding are being applied in South-west Kansas, where some new shallow fields have been discovered.

Data about the new fields are tabulated and the history of Western Kansas development is tabled by fields. The footage drilled is listed by years, and diagrams show the results of drilling, the reserves, and daily average production from year to year.

G. D. H.

1053.* Radioactivity and Petroleum. E. N. Tiratsoo. *Petroleum*, 1941, **4** (3), 58.—Helium, one of the end-products of radioactive change, is found in certain natural gases, and is associated with petroleum. Although some of this may be derived from the original cosmic atmosphere, the majority is presumed to be formed as a result of the radioactive decay of minerals in the earth's crust.

Considering an igneous source of radiation in juxtaposition to a Palæozoic crude, it is calculated that the energy released by 1 gm. rock since Devonian times is equivalent to 77 million calories. The effect of such an enormous quantity of energy on the associated oil needs investigation.

The action of α-particles on a pure member of the C_nH_{2n-2} series is to eliminate H_2 or lower saturated hydrocarbons, thus building up higher members by addition or condensation.

With the lower saturated hydrocarbons there are two ways in which these can be converted to liquids:

1. by repeated doubling by successive ionization;
2. by direct condensation of a sufficiently large number of "nascent unsaturates."

Similar results have been obtained by the action of ultra-violet light on aliphatic hydrocarbons.

Hence there is a method by which the higher hydrocarbons can be built up from the lower ones, whereas the thermal processes usually invoked cause only degradation. However, the chief obstacle to any radioactive theory of the origin of petroleum lies in the question of the disposal of the hydrogen formed by the action of α-particles on water as well as on hydrocarbons. It has been shown that the Gulf-Coast crudes tend to become more paraffinic as they grow older, and it has been suggested that this may be a "hydrogenation" process. On the other hand, a theory has been put forward that the hydrogen unites directly with carbon from plant and animal organisms to form hydrocarbons.

Thus the origin of petroleum is postulated as follows. Any organic substance containing, C, H, and N atoms breaks up by α-radiation to simple hydrocarbons and nitrogen. The hydrocarbons by further α-ray action are converted into a succession of higher members with the liberation of CH_4 and H_2—the latter gas eventually hydrogenating the oil. For the source of radiation it is only necessary to look to the sediments themselves, there being striking evidence that layers immediately underlying an oil-bed are extraordinarily rich in radioactive material.

The effect of α-rays on solid hydrocarbons has also been studied, and it was found that the melting point of the solid is raised and H_2 is liberated. X-ray analyses show that the crystals of saturated hydrocarbon are dispersed, melted, and then condensed as complex colloids by the action of the α-rays.

One other type of material must be considered: the asphaltic and carbonaceous. The widespread occurrence of uranium in these lends colour to a theory which explains them as the altered end-product of a series evolved by radiation from a simple ancestor.

D. L. S.

1054.* Recent Discoveries in Alberta Suggest Wide Extension of Fields. J. S. Irwin. *World Petrol.*, May 1941, **12** (5), 32.—A reflection survey and seven deep wells have indicated a north-west–south-east uplift in the Steveville district, and a major gas reserve has been proved in the basal Colorado (Cretaceous) at 2750–2950 ft. Gas and oil under high pressure have been found at the unconformable contact between the Madison and Lower Cretaceous at 3250–3330 ft., but a blow-out followed by salt-water incursion discouraged further testing for oil. Two wells have demonstrated oil and gas in quantity in Devonian limestone at 3970–4215 ft. and in the Madison at 3220–3290 ft.

There are considerable areas in Western Canada where the oil- and gas-bearing Cretaceous, Mississippian, and Devonian horizons lie at 2750–4200 ft.

At present there is no market for the gas. The gas from the Cretaceous has 150 gal. of naphtha per million cubic feet.

G. D. H.

1055.* Leasing Campaign Sweeps the Dakotas. Anon. *World Petrol.*, May 1941, **12** (5), 42.—4,000,000–7,000,000 acres have been leased in North and South Dakota, and recently activity has centred on the Lemmon geosyncline of the middle third of the two States.

In 1940 two stratigraphical tests were drilled, a third is under way, and a deep test has been planned.

There are many overlaps between the Upper Cretaceous and the Mississippian. The Big Snowy group of the Upper Mississippian on the western limb of the Williston basin of western North Dakota and Eastern Montana is considered to have commercial possibilities, for it is productive in two deep tests on the Baker–Glendive anticline. The Minnelusa, which has oil-showings in South Dakota, is another objective in the Williston basin, and the Sundance–Ellis may be sought where it wedges out on the north-east limb of the basin in North Dakota and Manitoba. The Devonian had 90 ft. of oil saturation in a deep test on the Baker–Glendive anticline. The Permian Minnekahta limestone may have oil possibilities deep in the basin.

In Saskatchewan three areas are under consideration—Lone Rock, 20 ml. south-west of Lloydminster, Muddy Lake, 7 ml. south of the Unity-Vera field, and north-east of the Battleview–Vermillion field.

G. D. H.

1056. Mesa Oil-field. S. G. Dolman. *California Oil-fields: Summary of Operations*, 1938, Vol. 24, No. 2.—The area designated Mesa Oil-field comprises 800 acres within

the city limits of Santa Barbara, California, although the proved area does not as yet exceed 115 acres. Only the eastern half of the field is at present productive, the western half having been drilled and abandoned. The first successful well to be drilled was completed in May 1929, in the Palisades tract, but the area as a whole was not a commercial success, only 20,909 brl. of oil being produced before it was completely abandoned in June 1930.

In September 1930 the Vista del Oceano tract was discovered, and it is recorded that in March 1940 four wells were still producing in the area. In March 1934 Fair Acres, the most important tract of the Mesa field, was discovered. The first well (Cole No. 1) started flowing at approximately 1500 brl. per day, but after flowing uncontrolled for two weeks the head of gas was dissipated and the well placed on the pump, making only 150 brl. per day. Of a total of sixty-five wells drilled, most of them behaved similarly to Cole No. 1, and all but eighteen have now been abandoned.

Summarily, 107 wells have been completed in the three areas of Mesa field. The average depth is 2000 ft. The total production for all areas to 1st January, 1940, was 4,303,591 brl., and the average production of oil per well per day at the same date, for the whole field, 10·4 brl. Of the oil produced, approximately 70% has been used for fuel oil and 30% for road oil and asphalt. H. B. M.

1057. Capitan Oil-field. S. G. Dolman. *California Oil-fields : Summary of Operations*, 1938, Vol. 24, No. 2.—The Capitan oil-field is located on an old Spanish grant land known as Canada del Corral Rancho, and comprises a proved area of some 200 acres on the sea-coast about 20 miles west of Santa Barbara. It lies partly in terraced, cultivated land and partly in the foothill pasture-land.

The report states that seventeen wells have been completed in the Vaqueros and seventeen in the Sespe zones by Shell Oil Co.; General Petroleum Corporation of California has completed thirteen wells in the Vaqueros and eight in the Sespe zones. Production charts give total monthly production of oil, gas, and water from Vaqueros and Sespe zones, respectively. Peak production was reached in the Sespe area between August 1935 and January, 1936, when wells " Erburu " 11, " Covarrubias 1 " 3, and " Covarrubias 1 " 4 were in flush production.

On the whole, however, production from this zone has been erratic, and differences in performances of wells in the same area hard to explain.

Until 1938 water from both zones showed no appreciable increase. Since that date Sespe water has increased, while oil production has declined. In the case of Vaqueros zone, however, increase of water has accompanied a marked decrease in oil production. This condition probably indicates coning of bottom water due to excessive oil production, and steps have already been taken to remedy it. H. B. M.

1058. Santa Maria Valley Oil-field. R. G. Frame. *California Oil-fields : Summary of Operations*, 1938, Vol. 24, No. 2.—The Santa Maria Valley oil-field lies 1½ miles south of the city of Santa Maria, Santa Barbara County, California. On 1st January, 1939, the proved area of the field was 4760 acres, the greater part of which is controlled by the Union Oil Co. of California, which also owns the only pipe-line through which oil is pumped to the port of Avila, 35 miles north-west of the field. General structure in the field is truncated and overlapped strata dipping in a southerly direction. These may be considered to form either the south flank of a large anticline known as the axis of the San Rafael uplift, or as the north slope of a syncline more than two miles deep, in the central portion between Santa Maria and Orcutt.

Oil prospecting in the area immediately surrounding the Santa Maria Valley field was in the past active, as is evidenced by some fifteen wells drilled without discovery of oil in commercial quantities. Also some twenty-five core-holes were drilled to obtain geological information, but no indications of favourable structure were found, probably owing to the angular unconformity between the Miocene strata and overlying Pliocene formations.

It was not until 1934, when wells No. " Moretti " 1 and No. " Enos " 1 were completed and brought into production, that evidence was gained of favourable structure in the area. Now productive limits on the north and east of the field have been fairly well defined, to the north by the drilling of several dry holes and demarcation

of the site where Monterey beds pinch out between the Sisquoc and the Franciscan formations. South and west limits are as yet undetermined.

Unfavourable marketing conditions have always curtailed production from Santa Maria Valley. The only means of transport available are the 8-inch pipe-line to Avila, or truck to a loading terminal near Casmalia, 16 miles away.

On 1st January, 1939, potential daily yield from the field was 112,360 brl., but the actual maximum daily yield for one month was only 11,658 brl. in September 1938. Up to 1st January, 1939, a total of 5,039,932 brl. of oil had been produced, and estimates of ultimate production range from 112 million to 500 million brl.

H. B. M.

Geophysics and Geochemistry.

1059.* Future of Geophysics. W. T. Born. *Bull. Amer. Assoc. Petrol. Geol.*, July 1941, **25**, 1256–1263.—The above subject formed the address given by the author, as president of the Society of Exploration Geophysicists, to a joint meeting of petroleum geologists, palæontologists, and mineralogists and exploration geophysicists at Houston in April 1941. He states that the petroleum industry may take pride in the fact that it is to-day in a position of being able to supply easily whatever demands are made upon it by reason of the present national defence programme, mainly owing to the successful activities of geologists and geophysicists and others concerned with exploratory activities of the petroleum industry in the past. These past successes enable the future to be met with a difficult but orderly exploration programme, rather than by a frenzied, inefficient scramble for immediately needed oil. The author emphasizes the necessity for the geologist and the geophysicist to learn to complement each other's efforts, and considers the best teams of the future will be an "optimistic" geologist and a "pessimistic" geophysicist—pessimistic in the sense that he will scrutinize his results with care, and refuse to allow himself or others to regard them as better than they are. In view of present-day successful studies it is considered that the re-survey of old areas for minor structures will be continued. The author is of opinion that areas already seismographed will again be surveyed, but at greater depths than previously, and considers that fruitful knowledge would be obtainable from a survey over a number of known stratigraphic traps, in the hope that the opportunity of comparing the results obtained with known conditions might enable similar conditions in the same areas to be recognized. He stresses the value of accurate mapping on two or more closely adjacent beds too close together to be resolved with present technique.

Various methods of employment are discussed, but it is not thought probable that a new prospecting method is likely to spring suddenly into being. Most of the development and experimental work in the field of geophysical prospecting during the past fifteen years has been aimed towards improving instrumentation and field technique, which have reached a high state of perfection, although understanding of many of the phenomena encountered is still lamentably imperfect and more time and money should be spent on research work on fundamental problems. The recent introduction of radioactivity logs of boreholes and the sonic method to locate fluid levels in production are an application of the technique used in seismic surveying and, whilst the aid given by the geologist is already extensive, that of the geophysicist will increase in importance and become applicable outside the field of exploratory work.

R. J. W.

1060.* Geodynamic Prospecting for Oil or Gas. S. J. Pirson. *Petrol. Engr*, Midyear 1941, **12** (10), 34.—Geodynamic prospecting purports to measure the rate of gas leakage from subterranean oil accumulations and from source-beds still in the process of forming oil and gas. In a dry or partly water-saturated horizon permeation, diffusion and effusion of gas take place. According to theory and a number of field measurements, the maximum rate of leakage occurs above the accumulation, not as a ring around it, except in special circumstances. The soil-analysis haloes observed seem due to changes in the adsorptive properties of soil by vertical migration of oil-field waters. It is estimated that to discover a field by geodynamic prospecting requires only one-fifth of the stations demanded by soil analysis.

In geodynamic prospecting a first profile should be run at right angles to the expected geological trend, with stations not more than 500–1000 ft. apart. If anomalous high leakages are observed, short profiles are run on each side at a distance of about 1500 ft. This process is continued until no more anomalous values are obtained. Holes 1¼–2 in. in diameter and 2–3 ft. deep are used, but they should be at least 50 ft. from places open to contamination, and not in ground saturated with water. At each station may be two or more holes into which piezometers are placed, and these measure the partial-pressure rise of a given gas over a known period (normally 24 hr., but for low leakage up to 10 days may be necessary). The piezometers are then sealed and sent to the laboratory for final checking and measurement.

The results are expressed as the rate of flow of gas through unit area in unit time. The highest readings observed so far are of the order of 30 cu. mm. of C_2H_4/sq. ft./day. These were obtained in Devonian oil- and gas-fields in Pennsylvania, and if the rate had been constant since Devonian times two trillion cu. ft. of gas/sq. ml. would have escaped, and would have depleted the fields unless there had been replenishment. According to this view, an oil-and-gas accumulation would be due to the presence of a barrier, the cap-rock, in the path of oil and gas leaking from the source-bed.

Geodynamic prospecting is a direct method for finding oil- and gas-pools under pressure. Depth determinations and separation of individual horizons are also possible within reasonable limits. G. D. H.

1061.* New Cycle of Petroleum Exploration. J. L. Adler. *World Petrol.*, June 1941, **12** (6), 64.—The first quarter of 1941 has produced evidence of the existence of a new cycle of petroleum exploration, and this may have received its initial impulse from the realization that the flush production in Illinois and Indiana—the only discovery of major importance east of the Rockies in the past 10 years—would be short-lived. It was also apparent that there is an advantage in having ample production in regions near the retail market. Restriction of foreign development has released funds, personnel, and to some extent materials for home exploration, and the demand for American oil has also risen. Efforts have been made to discover reserves before restrictions and increased costs make exploratory work difficult.

Surface geology is being used in areas where the more exact differentiation of outcrops permits the delineation of less prominent structural features than could be found by less detailed work. Core-drilling is of value where the oil-bearing series is covered unconformably by a relatively thin veneer. This type of drilling is becoming deeper, and, in addition to cores, provides data by means of electrical logs and chemical logs, and is useful on complex structures.

Magnetic methods have been of value in North Louisiana and Mississippi, but disappointing on the whole in Alabama, Georgia, and Florida, where, it must be admitted, lack of a considerable amount of sub-surface information renders interpretation of magnetic data difficult.

No generally recognized results of importance have been obtained with electrical transients. A revival of gravitational prospecting is due to the development of gravimeters which are capable of rapid operation, and so provide data at a very low cost. Very weak anomalies have been found in some cases to be significant.

Geochemical well-logging is of value in preventing the abandonment of a well just short of a possible producing horizon, or of an area because of a dry hole just outside the limits of future production.

Soil analysis is still considered too expensive for blanket surveys, but it is useful in determining the relative merits of prospects discovered by other means.

The analysis of plants for traces of elements has been suggested as a clue to the presence beneath the soil of formations which contain the same elements.

G. D. H.

1062.* Effectiveness of Exploration Methods. W. R. Ransome. *World Petrol.*, June 1941, **12** (6), 68.—The seismograph has discovered the majority of the geophysically located fields, and 200 seismograph crews are now at work in U.S.A., not many fewer than at the peak in 1937. Lahee has estimated that one out of every five wildcats drilled in 1940 on geophysical indications was a producer, whereas only

one in twenty-four was successful when located without the aid of geology and geophysics.

The ratio of dry holes to producers in geophysical prospecting seems to have become stable, but the size and value of the fields are decreasing. Thus, whilst technically more efficient, geophysics is declining in economic effectiveness.

In an effort to discover low-relief structures, various improvements in technique have been made, and it has been found that lateral changes in velocity can be of such a size as to mask small and even large structures if suitable allowances are not made.

Geochemistry makes the discovery of stratigraphic traps easier. G. D. H.

1063.* Direct Evidence Required to Discover Stratigraphic Traps. J. W. Merritt. *World Petrol.*, June 1941, **12** (6), 70.—The historical sequence of oil-finding methods is described, from seepages, search for folds, core-drilling, to geophysical methods. Stratigraphical traps are more difficult to find, for although the traps may be localized to some extent by geological studies, the drill must be used to find the location of the actual site of the deposit.

Within the past few years search has been made for traces of hydrocarbons escaping through the imperfectly sealing cover rocks, and characteristic patterns of hydrocarbon values have been found over producing areas. The high values generally occur over the margin of the deposit, irrespective of whether the trapping is structural or stratigraphic.

Geochemical well-logging has also been developed, and indications of the presence of an oil-horizon may be noted when it is yet 500–1000 ft. below, or some distance away laterally.

In geochemical surveying samples are taken over the area concerned and analysed for hydrocarbons. The results are plotted on a map and then interpreted.

G. D. H.

1064.* Water Prospecting with the Gravity-Meter. E. V. McCollum. *World Petrol.*, June 1941, **12** (6), 74.—The gravity-meter is admirably suited to work in swamps, bays, shallow or deep lakes, where reconnaissance data are required, since good coverage at relatively low cost is possible. Transport by boat is easy, and readings are obtained by setting the instrument on improvised piers, constructed on the spot, tree-stumps, etc. At times a boat with a central well, through which tripod legs can be lowered, is used, and in water of 20–25 ft. depth considerable areas have been worked using portable towers or piers.

The latest method is to place the instrument in a submersible chamber, and readings are taken electrically on a panel in the boat.

Twenty-five stations or more per day may be covered at times. G. D. H.

1065. Galitzin-Type Gravity Meter. G. I. Welch. *Rev. sci. Instrum.*, 1941, **12** (4), 179.—The factors governing the design of a gravity meter are discussed and the construction and characteristics of the gravity meter developed by the author are given. This instrument when used in the field gives results which are accurate to 0·06 milligal.

J. W. H.

Drilling.

1066.* Derrick-Carrying Portable Rigs Speed Drilling in California. T. P. Sanders. *Oil Gas J.*, 24.7.41, **40** (11), 38.—Two recent portable rigs are compared from the viewpoint of design rather than that of performance. One is a Shell rig and the other is a General Petroleum rig. The chief difference between the two rigs is in the derricks. The Shell derrick is a standard-type 87-ft. steel structure mounted on an 18 × 18 ft. base, which is made of steel I-beams and covered with wood flooring. Beneath the floor at each corner track-laying wheels are bolted to the frame. The derrick in upright position, with the hoist, engine, and the engine-house, is moved as a unit, being drawn by a tractor. The General Petroleum rig, on the other hand, has a 90-ft. telescoping derrick which folds over the engine and draw-works so that the

rubber-tyred unit can be pulled by a truck. While the Shell rig maintains the standard derrick to which all drillers have become accustomed, it offers certain limitations in regard to moving. Its width does not allow highway transportation, and its height makes it necessary to consider power-lines and other overhead obstacles.

Most of the wells drilled to date with the new Shell rig have been about 1900 ft. deep, but the rig is designed for all work up to 4000 ft. 4-in. drill-pipe is used, and the Mount Poso wells are completed with 8¼-in. combination strings of casing, as it is considered likely that large-volume electrical pumping equipment may be installed when water production becomes heavy.

Since the General Petroleum rig will handle 16,000 ft. of small-sized tubing, it is to be used for servicing the 11,500 ft. Rio Bravo wells when work of this kind becomes necessary. Its ability to move rapidly and without restrictions on the highway favours its use for such service. However, as long as the deep San Joaquin Valley wells continue to flow the rig will be used exclusively for the drilling of shallow wells.

Both the new drilling rigs were designed primarily to reduce moving expense. Success in this respect can be judged by the fact that either rig can be moved to a new location and set up ready for drilling in as little as 5 hours after the drill-pipe has been laid down. A. H. N.

1067.* Mechanical Rotaries Used for Drilling New Oklahoma Field. H. F. Simons. *Oil Gas J.*, 24.7.41, **40** (11), 44.—The practices of the new field at Guthrie are described. The rigs used, whilst not identical, all fall within one of three classes. The most commonly found rig at Guthrie is the two-engine compounded type with the engines setting one behind the other between the draw-works and pump. The engines can be run separately, with the front one driving the hoist and the rear one the pump; at Guthrie the engines are generally run compounded while drilling to obtain enough speed on the pump and rotary table. Engines on all these rigs use butane for fuel. Typical rigs as used by different companies are briefly described.

Contractors are furnishing the derricks. The companies have insisted, however, that a high substructure be used, so that the connections need not be placed in a cellar, but will be only a little below ground level. The substructures are set on 26 × 26 ft. concrete bases with heavy corners. The derricks are moved off immediately after completing the well.

All the rigs use 4½-in. internal upset drill-pipe for making the hole down to the point where the pay-string of 7-in. casing is run. For completion a string of 3½-in. internal upset drill-pipe is used. Some contractors carry a few joints of 6⅝-in. drill-pipe for making the approximately 300 ft. of 12¼-in. surface hole in which is run the 10¾-in. pipe. Size of hole drilled below the surface pipe is either 8¾ or 9-in. to total depth (5450 ft.). The 7-in. run in the hole varies from 22 lb./ft. to 28 lb./ft., depending on the operator. Some of the strings have been composed of 45-ft. joints, whilst others have used the shorter 30-ft. pipe. The pipe in the pay-string may be either seamless or welded. The same is true of the surface strings, where either seamless or welded pipe may be used. A. H. N.

1068.* Washover in Small Hole Shown Possible by Kansas Well. H. F. Simons. *Oil Gas J.*, 31.7.41, **40** (12), 146–147.—One of the problems accompanying the introduction of slim-hole drilling in Kansas has been the recovery of tools lost in the hole, an occurrence which is certain regardless of the care taken to keep the equipment in the best possible condition. Where small holes are being drilled, the clearance between the tool-joints and the hole is not great, and difficulty may be experienced in getting an overshot or washover string down over the fish. A recent fishing job in Kansas has shown that it is possible to recover 3½-in. drill-pipe from a 6¾-in. hole. The fishing job was occasioned by the sticking of an open-end string of pipe due to the hole sloughing while a cement job was being attempted to regain circulation. The washover job is detailed.

Total time consumed in fishing was 12 days, but 4 days were spent in getting over the fish, due to the fact that the original back off took place opposite a cave. The hole would probably have been cleaned up in less time than 8 days had it not been for this misfortune. While 12 days is more than is normally spent on a Kansas fishing job before skidding the rig or side-tracking, in this case the expenditure was worth while,

because of the tough drilling. The successful completion of the job also proves definitely what was only believed previously—that it is possible to washover a fish in a small-diameter hole. A. H. N.

1069.* Reducing Hazards in Handling Rope. F. L. Spangler. *Oil Gas J.*, 7.8.41, **40** (13), 34.—Injuries to men handling wire rope are of three kinds. First there is the danger of deep-seated puncture wounds or skin lacerations caused by the sharp ends of broken wires sticking out from worn ropes or by the exposed ends of the rope or of the wire-ends in a spliced section. Then there is the lashing or looping of an unmanageable rope, which can take off a man's limb or decapitate him if he is caught in its coils. As an example of the third type of injury, a man's glove may be caught by a broken wire or strand and his hand be pulled into a drum or sheave. Specific cases are discussed in the light of answers given by various companies to a questionnaire.

The reports from three companies say that preformed rope seldom wickers, regardless of the extent of wear, and is therefore much less dangerous to handle than non-preformed rope. Other advantages of preformed rope from a safety standpoint are revealed by a company which reports: "We are now using preformed rope exclusively; it does not unravel when cut and it does not kink when used for hoisting."

The need for proper training of men handling rope is emphasized by four companies, and one says that rope-handling should be reduced to the absolute minimum. Two pointed out the need for proper lubrication to prevent rust, proper training of men in good splicing, winding, or clamping of rope before cutting, so that the "ends" will not explode and the wires fly out, and brazing the rope-ends to make them blunt and eliminate the danger of exposure to sharp wire-ends. Drivers of winch-trucks should realize their responsibility in preventing injuries from rope-handling and should be trained with this in view. A. H. N.

1070.* Cathead Most Dangerous Point On Rotary Drilling Rig. H. F. Simons. *Oil Gas J.*, 14.8.41, **40** (14), 42–43.—This paper is based on a report on accidents issued by the Bureau of Mines, from which it appears that the cathead is the most dangerous point on the rig. The line-shaft and cathead may be running at 200 r.p.m. and the rope pulling some object moving only 1 ft./min. around the cathead. If the rope becomes tangled it begins to move at 760 ft./min. if a 14-in. cathead is being used. Unless the man running the cathead is prepared for the emergency, he becomes fastened in the cathead by one arm or hand, and is jerked from the floor and spun round at 200 r.p.m.

The type of injuries when the man is not killed are shown in the report mentioned above. Out of thirteen reported accidents on the cathead, the injuries included six to the shoulder and arms and seven to the hands and fingers. In these thirteen accidents there were four fractures and five amputations.

The most common mistake made by cathead men is the grasping of the rope with the right hand turned palm downward. This places the back of the hand between the rope and the cathead should it become fouled while either placing the rope on the cathead or taking it off. With the palm upward, opening the hand releases the rope and the fingers are removed from danger. Another common fault is the throwing of large loops of rope on the cathead instead of placing tight loops on it.

As the cathead depends on friction for its operation, the faster the line-shaft is turned, the greater is its power. Cathead men prefer a fairly high speed, as the rope is easier to handle, although they know that the danger is thereby increased. A moderate speed and an additional coil of rope on the cathead increase the work slightly, but also decrease the danger. The use of too many coils on the cathead, so that the weight of the operating end of the rope is sufficient force to pull a fairly heavy object on the working end, is also dangerous.

Laying of the hand on the coils is not dangerous, although it may appear to be. This permits the strain on the working end of the rope to be released or reduced while leaving the rope on the cathead. A. H. N.

1071.* Effective Mud System for Deep Drilling. N. Williams. *Oil Gas J.*, 4.9.41, **40** (17), 32–33.—A particular system as used by one company on the Gulf Coast is

described and unusual efficiency is claimed for it. Rigs of this company call for two 20-in. mud pumps. These are so manifolded that either can be used in regular mud circulation to the well or for mud mixing or other service. Also both pumps can be operated together in mud circulation, either in parallel when volume of mud is required, or in compound when greater pressure rather than volume is needed.

The pumps take suction from separate but adjoining suction pits, which in this case are of excavated earthen construction, each about 12 × 20 ft. in size. Like the pumps, either pit can be used separately for mud-suction to the well, or for mixing of mud, depending on the use to which the respective pumps are being put at the time; or suction can be taken simultaneously from both pits, if it is desired to operate the pumps in parallel for mud circulation.

A gate connects the two pits. For use of either pit independently of the other, the gate is kept closed. With the gate opened the mud can be emptied from either pit to the other. Each pit has a gate-controlled opening from the common mud ditch, which permits discharge of the mud stream from the well into either or both pits, as desired. Thus, by opening or closing the gates in various combinations, the mud circulation can be diverted in any number of different ways through the pits to the suction pits.

By closing the gate from the mud ditch to the first pit, opening the gate to the second pit, and closing the gate between the two pits, the mud circulation can be confined to the second pit; or, by opening the gate connecting the pits, the mud can be circulated in succession from the second pit to the first pit, and thence to the suction pump of the first pit. With the gate from the mud ditch to the first pit open, the gate from the ditch to the second pit and that between the pits closed, the mud circulation can be confined to the first pit. By opening the gate between the pits, the mud can then be circulated successively from the first pit to the second pit, and thence to the suction of the pump of that pit.

Operations under normal and abnormal drilling conditions are described, together with a steam-jet degasser using baffles in an inclined tube. A. H. N.

1072.* Interesting Results from Deep Experimental Drilling Programme. S. Fox. *Oil Wkly*, 21.7.41, **102** (7), 17–19.—Experience with drill-casing has thus far been completely satisfactory. The cost of casing built up for drilling is approximately 12 cents/ft. more than regular casing, which is considerably less per ft. than the cost of drill-pipe, maintenance, and depreciation. In addition this immediate saving is also increased by economies of operation made possible by use of the drill-casing.

Among these is the matter of time. The average time of drilling has decreased by approximately 10 days/well since the company began the drill-casing programme. This decrease is due not so much to a reduction of actual drilling time itself, but is credited to the greater speed and efficiency of the method made possible by use of drill-casing.

It is concluded that results from this new drilling practice have been entirely successful, and initial mechanical difficulties were quickly overcome. Although several joints of pipe may be damaged in the drilling of a well, they are easily repaired. Abrasion occurring from the contact of the pipe with the walls of the hole necessitates replacement of a few worn couplings, but no apparent damage is done to the body of the pipe. The drill-casing withstands the drilling stresses satisfactorily without pipe twist-offs. It is reasonable to expect that the use of drill-casing will have application to other fields with good results. A. H. N.

1073.* Gas Box Saves Mud in High-Pressure Drilling Area. G. B. Nicholson. *Oil Wkly*, 21.7.41, **102** (7), 26.—The apparatus consists of a 28-ft. wooden tunnel or box, inside dimensions 4 × 6 ft., and an 8-ft. chimney erected 6 ft. from the end nearest the mud pits. Blowing mud is directed into the box by 4-in. pipes leading directly from the mud-return annulus, its volume restricted by chokes of desired size placed on the pipes near the entrance. Sturdily constructed and heavily reinforced, the box absorbs the force of the fluid stream and confines the blow, separating the gas and expelling it into the air while turning mud into the pits. Closed on the mud pit, and except for a large exit door leading out at a 90° angle, the lengthy tunnel allows

time for separation, despite the turbulence, and gas is drawn by vacuum from the chimney near the end by blowing steam through it.

The gas-box is used only when a well attempts to blow out and the shale-shaker and degasser are not sufficient to handle the pressure and volume of gas and fluid. At that time valves on the mud line are manipulated to direct flow into one of the two parallel 4-in. lines leading from the well to the box, the fluid by-passing both shale-shaker and degasser with flow around the casing-head sealed off, forcing all circulation returns to enter the mud pipe. The apparatus is located sufficiently distant from the rig for safety and non-interference with operations, and at the entrance to the box, valves on both mud lines contain positive chokes to regulate flow and govern the amount of back pressure held against flow from the casing. As only one line is used at a time, chokes are easily changed to obtain proper control. A short distance beyond the choke-valves the 4-in. open-end line delivers drilling fluid into the box.

A. H. N.

1074.* Automatic Pressure Control Aids Drilling of Wild Well. Anon. *Oil Wkly*, 28.7.41, **102** (8), 17.—The procedure used in drilling under pressure, with an ingenious automatic back-pressure maintenance equipment, of a formation with an abnormally high pressure, is detailed in this exhaustive paper. The rig, designed and equipped with hydraulic rotary and pull-down yoke for control of the flush-joint drill-pipe through drilling packer, used a 136-ft. steel derrick, draw-works with hydromatic brake, and steam drilling engine. The rotary table was equipped with hydraulic cylinders which permitted it to be raised for a grip on the kelly, and then lowered under controlled pressure to maintain feed on the bit and secure the pipe against being blown out of the hole.

For coming out of the hole or running pipe, a hydraulically actuated pull-down yoke was set, and the drilling crews were trained in its use, so that they would be thoroughly familiar with the operations should well conditions require snubbing of the string.

To provide space for the various controls required in maintaining back pressure on the mud in the hole, a balcony or auxiliary operating platform was fabricated from steel salvaged from the first derrick over the hole. This space, 30 ft. long by 8 ft. wide, was set at derrick-floor level and to the right of the driller's stand, so that signals between driller and control operator could be observed at all times.

The platform carried the mud-choke manifold, individual and plainly labelled controls for the master gate, mud-return main, flow-lines, drilling blowout preventer, emergency blow-out preventers, gauges and recording chart for checking input and outflow mud pressures, and a booster pump for stepping up hydraulic pressures in the ram-actuating systems of the blowout preventers.

Maintenance of uniform working pressure on the well at all times was attained through use of an 18-in. pump which constantly "floated" on the mud column, a modified boiler feed-water type of regulator being tied in with the mud line so that any variation was communicated to the throttle of the pump and the flow varied accordingly.

The four adjustable chokes, one each on the 2-in. lines taking flow from the 4-in. mud line at the well, were set to maintain approximately the desired back pressure on the well under normal operating conditions, leaving the floating pressure-maintenance pump to make up for any fluid lost into the formation, and to compensate for void created as the drill-pipe was withdrawn through the drilling blow-out preventer when coming out of the hole.

Use of the pressure-maintenance pump gave accurate compensation for even minute fluctuations in mud-stream volume or pressure, and eliminated the necessity for attempting to maintain this uniform pressure through hand manipulation of the various chokes on the mud-distribution panel. With the actuating line for the pressure-control diaphragm tied to the ascending mud column below the master gate, any variation occurring was felt at the diaphragm while the mud stream was still under full annulus conditions, and before any branches or split streams could affect actual pressures and show fictitious readings of the conditions.

The paper is well illustrated both diagrammatically and photographically.

A. H. N.

1075.* Acidizing before Cementing Helps Form an Effective Bottom-Hole Water Block. F. B. Taylor. *Oil Wkly*, 4.8.41, **102** (9), 17.—Control of formation water has long been a problem in Kansas production. Arbuckle lime, the dominant producing stratum in the western part of the State, normally carries excessive volumes of water. As there is no dissolved gas to expand and take the place of the crude produced, formation water immediately begins to move laterally towards the well, and generally intrudes into the borehole within a few months.

Various methods have been employed to plug off the water section as it progressively rises, for production of large quantities of water does not mean that the crude oil in the reservoir has been exhausted. Recently some companies have been devoting their efforts towards creating a non-permeable cement bottom-hole water-block after the stratum has been opened somewhat by controlled acid treatment. While the method is yet too young to have been applied extensively, results so far obtained have been distinctly promising.

Through application of this new technique, a cement block that extends back into the formation through opened crevices is obtained, instead of a cement plug in the bottom of the hole that adheres merely to the face of the water section. The permeability of the water zone is lowered to practically zero by forcing cement into the pore spaces made available by the acid treatment. As the block extends into the formation itself, it is effective beyond the point of greatest pressure differential while the well is being produced; thus it not only acts as a plug, but also influences the formation of a water-cone by retarding water migration in the vicinity of the well, and acts to reduce further coning in the event of the cone having already become established. Details of the method are given. A. H. N.

1076.* California Test is Deepest by Electric Power and had Longest Uncased Hole. Anon. *Oil Wkly*, 4.8.41, **102** (9), 23.—Two records without parallel in the drilling of deep wells were achieved by Honolulu Oil Corporation in the drilling of its No. 25-P deep test to 14,622 ft. in the old Buena Vista oil-field in Kern County, California.

First, from 3101 ft. to bottom, a distance of 11,521 ft. drilling was in open hole. This amount of uncased hole is believed to have been hitherto unequalled, and attests the care and precision of workmanship on the derrick floor, as well as the high degree of expert supervision over a miscellaneous number of items, such as drilling fluids, rate of penetration, maximum capacities of equipment employed, and a number of other factors.

Second, except for small standby units, electric power was used in the drilling, making it the deepest well ever drilled with electric power.

Details are given. A. H. N.

1077.* Floating Barge Expedites Shallow Marine Drilling. G. M. Nicholson. *Oil Wkly*, 11.8.41, **102** (10), 19.—A non-submersible barge constructed especially for drilling to the 2300-ft. oil-producing sand in the West Lake Verrett field, South Louisiana, and for deep work-over jobs is described. Assembled with the objective of allowing fast completions facilitated by ready mobility when changing locations, the entire rig assembly is mounted on a single barge, and includes a 126-ft. derrick and attendant equipment such as a rotary and draw-works driven by diesel-power equipment, mud pump, mud tanks, and pipe racks, with all apparatus transported in a single operation necessitating little expense, and eliminating time consumed in sinking or refloating the barge, as is usually the case with marine-drilling barges. Use of the barge avoids waste which would be incurred in occupying larger and more expensive equipment on wells where load requirements are light.

The barge and equipment are described and illustrated photographically. The barge requires only 4½ ft. of water when fully loaded to its moving weight, exclusive of its complement of 3½-in. drill-pipe on the auxiliary barge, allowing a deck clearance of 18 in. above the water level. Only a short time is required for its movement, it being a simple task to raise the corner spuds and move rig during cementing time for work on another well, such as swabbing or squeezing, then moving back to the original well in time for completion. A. H. N.

1078.* Semi-Permanent Boiler-Setting Permits Alignment. Anon. *Oil Wkly*, 18.8.41, **102** (11), 19–20.—One company whose work justifies semi-permanent mountings of the boilers has worked out a system of boiler substructure or skeleton foundation which, simply laid on planks over the ground, affords uniform and rigid support at comparatively low cost.

Alike in design, squat, triangularly braced substructures are used at both ends of the boiler unit, the raw material being discarded joints of standard drill-pipe, cut to length with cutting torch and welded into a series of joined A-frames. The supports for the smoke-box end are made as a series of A-frames with a continuous rail under each series of legs. A continuous rail is also used across the apex of each frame, each section of supports being made as long as desired, but always more than one boiler. Diagonal bracing is used by stepping in a joint of pipe at the leg of one A-frame and bringing the opposite end of the brace to the top rail, central between each pair of frames. The next brace starts at the leg of the next frame, on the opposite side, and is brought to the centre and welded. Adequate cross braces are welded between the legs of each frame to prevent spreading when weight is applied.

Details are given. A. H. N.

1079.* Rig in Centre of Crater Helps Kill Wild Well. Anon. *Oil Wkly*, 18.8.41, **102** (11), 33–35.—Setting up of a drilling derrick in the middle of a well crater and the drilling of more than 500 ft. of hole were particularly interesting phases of methods used in bringing a well under control late in July, after it had blown wild since March 31, 1939. The well, located in the McFaddin field of Victoria County, Texas, was bottomed at 4260 ft. and had penetrated several high-pressure gas-sands when it blew out. Surface fittings were soon cut out, and the well cratered.

The series of operations that finally led to the setting up of a small derrick in the middle of the crater in order to drill down beside the original hole and then successfully kill the well, are illustrated photographically. The operations leading to the killing of the well lasted approximately 3½ months, ending in the latter part of July this year. Despite the hazardous nature of this particular job, no injuries were suffered by any of the workmen. A. H. N.

1080.* Derrick Substructure Centralizes Load at Corners. Anon. *Oil Wkly*, 1.9.41, **102** (13), 21–22.—An unusual derrick substructure is used by one company for drilling deep wells in the Gibson field, Louisiana Gulf Coast, conveying all pipe and rotary loads to the four corner columns by means of heavy horizontal trusses that eliminate need of rotary or other vertical supporting posts under the derrick, and allowing increased working space around the casing-head valves. Cost of this company's standardized method of concrete flooring for the area under the derrick is reduced, as less concrete is required by this substructure for floor and for the shallow cellar which is made possible by high ceiling clearance. The base has been used on several wells with depths in excess of 11,000 ft., drilling with only the heaviest available equipment through high-pressure formations, and supervising engineers state that its design offers strength equal to conventional substructures, with apparent absorption of rig vibrations.

In eliminating rotary posts, the substructure supports the derrick and the pipe-load standing in the derrick or held in the rotary only at the four corners, with the load transferred to the corner posts by means of six all-welded, carefully fabricated trusses, four extending between the derrick legs and two parallel rotary trusses crossing near the centre. All trusses are constructed of heavy channels welded to steel plates, and consist of horizontal top and bottom cords with angular and perpendicular bracing between. The trusses extending between derrick corners on the tool-ramp and mud-pump sides, as well as the two rotary trusses under the derrick, are 5 ft. high, allowing ample clearance to haul in equipment and for persons to walk underneath, although clearance on draw-works and window-sides is only 2 ft. 3 ins. The derrick floor is elevated to 10 ft., providing abundant space for easy manipulation of valves and facilitating washing of the concrete floor. Mud return lines which leave the casing-head comprise the only horizontal piping, while the sole vertical pipe extending through the floor is the rathole conductor pipe, with vertical supports eliminated. A. H. N.

1081.* Underreaming to Straighten Hole in Well Drilled on Townsite Lot. H. L. Flood. *Petrol. Engr*, August 1941, **12** (12), 27–28.—A procedure, tried for the first time, for straightening a well with excessive deviation is described. Although the maximum deviation had not become unduly excessive, the operator preferred to straighten the hole, and thus avoid the possibility of drilling into one of the nearby wells.

The principal points of interest in the hole-straightening operation rest in: (1) the fact that the deviation was corrected before surface pipe had been set, and (2) the use of successively larger underreamers (to 30 in.) to create a wide enough shoulder to permit "re-spudding" a new hole that would have a more nearly vertical axis.

The expanding wall-scraper tool used on this job consists of an alloy-steel body containing a piston to which two blades are connected, the latter being mounted in such a way that the blades retract into the body while running in or out of the hole. At the desired time the piston may be forced downward by increasing the pump pressure on the mud, thus expanding the blades outward and upward against the wall of the hole. As the drill-pipe rotates, the blades cut their way to a fully expanded position, and are held in this cutting position by pressure against the shoulder that has been created in the formation. If the formation has a soft consistency, the blades are held in their expanded position by pump pressure.

In the first underreaming operation the 12¼-in. hole was enlarged to 15-in. diameter from depths of 1350–1400 ft. The 15-in. reamer blades were then removed from the tool and the hole was again enlarged, using 19-in. blades, from 1360 to 1400 ft. The third step consisted of enlarging the hole from 19 in. to 24 in. from depths of 1365–1400 ft. Finally, the 24-in. blades were replaced with 30-in. reamer blades, and the hole was enlarged to the latter diameter for a distance of 72 ft. (from 1370 to 1442 ft.).

A. H. N.

1082.* Well Completions Improved by Concentration of Prepared Bentonite in Drilling-in Fluid. W. A. Sawdon. *Petrol. Engr*, August 1941, **12** (12), 38.—Recent practices established by some of the companies in a number of fields in California, as well as in a number of other districts throughout the United States, indicate the advantage of changing the mud before entering the sand. This drilling-in mud in many cases consists entirely of prepared bentonite and water, and in others (where a little more weight is necessary) of well-conditioned mud fluid to which sufficient prepared bentonite is added after proper thinning to allow for the high concentration of the bentonite.

The object of changing the drilling fluid when drilling through the sand is to obtain a mud that will deposit a cake on the face of the sand that will not only prevent water loss while drilling, but will be so thin, soft, and easy to remove that no washing will be necessary. The fluid, composed entirely of prepared bentonite and water, not only possesses these properties in the highest degree, but also provides the viscosity and gel strength necessary to bring up cuttings and hold them in suspension in the event of circulation being stopped. For use when drilling low-pressure sands, such a fluid has the advantage of low weight and, due to its extreme colloidal properties, will have a tendency to prevent loss of circulation into very porous or fractured sand.

Where drilling-in requires weight to some extent the prepared bentonite can be concentrated in the fluid to give the desired qualities, and weight material added to provide the necessary weight. Although this discussion is confined to the fluid used for drilling through the oil-producing zone or zones, there are instances in which the circulating fluid used for drilling the entire well has been composed of prepared bentonite and water, weight being added if and when formation pressures have to be overcome. The use of prepared bentonite for drilling-in at several fields shows applications under different conditions.

The actual variants of the methods used in different fields are described, with a discussion of specific problems met.

A. H. N.

1083.* Removable-Type Hydraulic Jet-Gun Used in Acidizing. C. A. Pitts and C. F. Seeber. *Petrol. Engr*, August 1941, **12** (12), 44.—Most hydraulic guns are attached to the tubing, thus rendering it necessary to make a round trip with the tubing to recover the gun at the end of the treatment. To eliminate this, a gun has been devised that may be dropped in the tubing and caused to seat on a special seating

nipple. This gun is retrievable by one of two methods. It can either be retrieved with a measuring line, or pumped out when it is possible to reverse circulation. The special seating nipple supplied is so designed that any standard A.P.I. insert barrel will fit it. This eliminates any trip with the tubing.

The advantages of this removable-type gun are many. Cementing off bottom of wells through tubing and subsequently jetting out the excess cement above the pay zone without removal of the tubing from the hole is becoming a standard practice in some areas. Furthermore, by simply changing the tip of the jet-gun it is possible to accomplish any type of jetting job in minimum time and at minimum expense to the operator.

The hydrodynamics of the jetting action are discussed. A coefficient of discharge equal to 0·976 has been realized.

Many successful jetting jobs have been run under various conditions and for different purposes. For each type of job a particular type of acid and a particular method of operation are used. The two principal classes of uses for jets are: (1) for vertical drilling and (2) for horizontal drilling. For vertical drilling a special jet-tip is used, which has one large orifice pointed the correct number of degrees from vertical, and one small orifice pointed horizontally. This allows cement or limestone to be drilled at a rate comparable to cable-tool drilling, and saves the operator the expense of moving in cable tools or other drilling equipment. A cementing plug is being developed that is drillable with acid jet-guns, thus making it possible to service any well when casing leaks are present. The casing can be bridged below the leak, the acid-soluble plug and Cal-Seal used, a squeeze made through the leak and the pipe cleaned out with the jet-gun.

In a special method, known as water control, wells are jetted horizontally to open the water-bearing formation; cement is then carefully balanced into the formation, leaving a plug that covers both water and oil-pay, after which, with this special drilling jet-tip, the excess cement is removed a few inches at a time. As soon as any permeability is reached—indicated by loss or gain of fluid at the surface—drilling is stopped and the well tested for production. A. H. N.

1084.* Horizontal Wells Are All in Pay—and Flow by Gravity. L. Ranney. *Petrol. Engr*, August 1941, **12** (12), 127.—The vital point of such development is and always has been absolute control of the drilling bit, and the ability to turn the well up or down at will. In drilling some 7500 ft. of horizontal oil-wells, always under control, it is believed that the technique has been fairly well mastered. In fact, turning a hole to follow a predetermined course presents no greater difficulty at 3000 ft. than at 100 ft. from the mouth—no whipstocks are used. A surveying instrument has been developed, integral with the core-barrel, that automatically surveys the hole whenever a core is taken.

In an experiment conducted in South-eastern Ohio six wells were drilled horizontally from a shaft in the First Cow Run Sandstone. These 3-in. wells were drilled in opposite pairs, half of them to property lines. While a 50-ft. core was being pulled from one well, the drill rods (and duplicate tools) were being run into the opposite well. This was accomplished by a new machine, known as the "rod puller," which moves the rods at the rate of 100 ft./min. The drill-rods, in 10 ft. lengths, were not disconnected until both wells were completed. In deep holes this reduces drilling time by at least 75%.

In all the drilling operation the tools were never stuck or frozen; the holes were surveyed every 50 ft. and corrected when necessary; there were no fishing jobs; two men operated the drilling machine, with 20 h.p.; during all the experimental period, including stops and shutdowns for supplies, the average rate of drilling was 55 ft./7-hr. shift; when tools and supplies were on hand, often more than 100 ft. of hole was drilled per shift. To the south the bottom of the sand was level and the holes were flat, but to the north the sand was wavy and the holes followed the waves. The mixture of oil and return drill-water passed through a separator; the oil was saved in a closed tank, and then pumped to the surface. During the entire experiment no man suffered even a minor accident; tests by a methane detector in the centre of the work-chamber never showed more than 0·1% of gas; ventilation was by a blower at the surface and an 8-in. suction pipe. The cost of drilling, including

experimentation, was 90 cents per ft. of hole; 100 ft. of light 3½-in. casing was grouted in each well.

The greatest surprise was the result of shooting, which affected a vast area.

A. H. N.

1085. Patents on Drilling. J. F. Chappell. U.S.P. 2,245,571, 17.6.41. Appl. 16.2.39. Fishing tool.

R. W. Jones, Jr. U.S.P. 2,245,592, 17.6.41. Appl. 21.11.39. Well-pipe support and gripping device.

R. C. Baker. U.S.P. 2,245,638, 17.6.41. Appl. 25.7.39. Circulation and expansion joint for well devices.

J. R. Betts. U.S.P. 2,245,750, 17.6.41. Appl. 25.11.38. Well-boring bucket and method of boring wells.

J. Johnson. U.S.P. 2,245,786, 17.6.41. Appl. 3.2.40. Jarring tool.

J. F. Bagby. U.S.P. 2,245,847, 17.6.41. Appl. 22.6.39. Pipe or hose-coupling.

J. W. Weir and H. S. Montgomery. U.S.P. 2,245,886, 17.6.41. Appl. 11.7.38. Method of drilling wells using mud and acid.

G. K. Clair. U.S.P. 2,245,960, 17.6.41. Appl. 10.3.39. Rotary well-drilling apparatus.

H. W. Graham. U.S.P. 2,246,038, 17.6.41. Appl. 23.2.39. Integral joint drill-pipe section.

R. Ring. U.S.P. 2,246,319, 17.6.41. Appl. 13.1.40. Well-surveying instrument with an electrolytic recorder.

R. W. Smith. U.S.P. 2,246,417, 17.6.41. Appl. 18.6.38. Means for borehole orienting and surveying.

C. W. Froome and F. C. Boyd. U.S.P. 2,246,418, 17.6.41. Appl. 14.3.38. Art of well-drilling with a drill-pipe made in the form of a spiral.

P. Jones. U.S.P. 2,246,519, 24.6.41. Appl. 18.3.39. Drift recorder for drilling wells.

H. Allen. U.S.P. 2,246,709, 24.6.41. Appl., 21.8.39. Blow-out preventer.

G. J. Barrett and S. Robichaux. U.S.P. 2,246,711, 24.6.41. Appl. 16.11.39. Cutting-tool shaped to enter a pipe and cut by rotation.

F. L. Pivoto. U.S.P. 2,246,812, 24.6.41. Appl. 26.9.38. Welded-on blade-bit.

F. Huntsinger. U.S.P. 2,247,173, 24.6.41. Appl. 27.3.39. Drilling collar.

D. Silverman and R. W. Stuart. U.S.P. 2,247,417, 1.7.41. Appl. 6.3.40. Electric logging a well during drilling.

J. T. Phipps. U.S.P. 2,247,560, 1.7.41. Appl. 27.5.40. Jar with a shell and mandrel telescopically arranged.

H. W. Cardwell. U.S.P. 2,247,606, 1.7.41. Appl. 25.2.38. Draw-works with a friction clutch.

R. A. Mitchell. U.S.P. 2,247,729, 1.7.41. Appl. 25.8.39. Combination cable-tool and wire-line core-barrel.

E. R. Armstrong. U.S.P. 2,248,051, 8.7.41. Appl. 28.12.38. Offshore drilling rig supported on a buoyancy unit and vertical, extensible supports.

D. Scaramucci. U.S.P. 2,248,124, 8.7.41. Appl. 4.10.39. Well-casing attachment to be connected to the end of a casing.

D. Scaramucci. U.S.P. 2,248,125, 8.7.41. Appl. 4.10.39. Wash-down and cementing attachment for well casings.

E. L. Crawford. U.S.P. 2,248,160, 8.7.41. Appl. 12.8.38. Well apparatus comprising a drill-stem and a sleeve with helical springs.

P. H. Granger. U.S.P. 2,248,169, 8.7.41. Appl. 26.7.40. Oil-well tool to be used in combination of a well casing and a string of tubing adapted to be moved vertically within the casing.

A. C. Catland. U.S.P. 2,248,339, 8.7.41. Appl. 23.10.39. Roller cutter for rotary-well drilling.

A. C. Catland. U.S.P. 2,248,340, 8.7.41. Appl. 26.7.40. Rock-bit for rotary-well drilling.

A. Osolin. U.S.P. 2,248,434, 8.7.41. Appl. 26.3.38. Mud-gun.

S. P. Hart. U.S.P. 2,248,457, 8.7.41. Appl. 21.7.38. Treatment of oil-wells to prevent heaving shale troubles by means of casein and a hardening material.

J. G. Phillips. U.S.P. 2,248,908, 8.7.41. Appl. 2.8.40. Self-expanding well-plug used in cementing.

D. W. Auld and L. J. Weber. U.S.P. 2,248,910, 8.7.41. Appl. 29.8.39. Pressure retaining core-barrel and coring assembly.

R. L. Crandall. U.S.P. 2,249,117, 15.7.41. Appl. 23.12.39. Cable spooling device with a relatively stationary cable-guide pulley and a cable drum.

C. J. Haynes. U.S.P. 2,249,358, 15.7.41. Appl. 30.12.39. Fishing tool for an object suspended on a cable.

E. F. Westall. U.S.P. 2,249,511, 15.7.41. Appl. 1.9.36. Apparatus and method for cementing wells.

J. T. Phipps. U.S.P. 2,249,578, 15.7.41. Appl. 18.11.39. Roller bit for oil-well drilling.

P. W. Thomure. U.S.P. 2,249,585, 15.7.41. Appl. 22.4.40. Device for pulling pipes and the like from well.

A. Boynton. U.S.P. 2,250,463, 29.7.41. Appl. 28.11.38. Cable-pull overshot of a releasable type.

E. W. Dodge. U.S.P. 2,250,574, 29.7.41. Appl. 1.3.39. Explosive rotary jar for deep-well equipment.

R. G. De La Mater. U.S.P. 2,250,628, 29.7.41. Appl. 28.1.39. Walking-beam assembly.

K. E. Waggener. U.S.P. 2,250,688, 29.7.41. Appl. 30.9.40. Cut indicating inside cutter for well-pipes.

W. J. Crites and W. C. Rodgers. U.S.P. 2,250,703, 29.7.41. Appl. 18.11.38. Apparatus for locating casing seats by electromagnetic means measuring the magnetic permeability in the well-bore.

R. H. Landers. U.S.P. 2,250,836, 29.7.41. Appl. 27.5.40. Pipe-clamp.

L. S. Dewees. U.S.P. 2,251,040, 29.7.41. Appl. 9.1.39. Means for measuring rotation of apparatus within drill-pipe or the like.

R. E. Chapman. U.S.P. 2,251,113, 29.7.41. Appl. 29.12.39. Device for pulling pipes or well-casings.

C. J. Gardner. U.S.P. 2,251,125, 29.7.41. Appl. 2.1.40. Safety device adapted for passage through well-pipes and having spring-controlled anchoring means.

G. R. Watson. U.S.P. 2,251,309, 5.8.41. Appl. 16.9.37. Multiuse winch-tool for well drills.

W. G. L. Smith. U.S.P. 2,251,428, 5.8.41. Appl. 23.12.39. Drill-pipe protector comprising two semi-cylindrical metal frames.

L. P. Kinnear. U.S.P. 2,251,679, 5.8.41. Appl. 29.11.37. Core-drill apparatus with a coring barrel.

L. F. Athy and H. R. Prescott. U.S.P. 2,251,817, 5.8.41. Appl. 18.4.38. Method of borehole logging by means of A.C. acting on a vibratory means.

A. B. Severn. U.S.P. 2,251,897, 5.8.41. Appl. 11.5.39. Thread protector for threaded pipes.

B. S. Smith. U.S.P. 2,251,900, 5.8.41. Appl. 24.9.38. Well surveying by means of passing current through a conductor within the hole and subjecting the conductor to a magnetic flux.

C. E. Burt. U.S.P. 2,251,977, 12.8.41. Appl. 23.12.39. Well-cementing apparatus.

N. W. Thompson. U.S.P. 2,252,050, 12.8.41. Appl. 30.9.39. Apparatus for circulating drilling fluids.

T. A. Creighton. U.S.P. 2,252,168, 12.8.41. Appl. 17.6.40. Well-bit.

R. De Long. U.S.P. 2,252,620, 12.8.41. Appl. 20.5.40. Coring device of the side wall type.

R. Cross and W. M. Cross, Jr. U.S.P. 2,252,669, 12.8.41. Appl. 9.9.37. Method of drilling oil- and gas-wells using a brine drilling fluid capable of precipitating cellulose or cellulose hydrate from a zinc chloride solution of cellulose.

H. W. Thornburg. U.S.P. 2,252,741. 19.8.41. Appl. 10.2.38. Spudding mechanism for cable-tool drills.

A. L. Armentrout. U.S.P. 2,252,912, 19.8.41. Appl. 6.3.39. Well-tool for use on a well-string comprising a cutting head.

V. Parkin. U.S.P. 2,252,978, 19.8.41. Appl. 22.6.38. Drill-stem protector.

J. O. Tow. U.S.P. 2,252,996, 19.8.41. Appl. 14.11.39. Gun perforator.

G. K. Clair. U.S.P. 2,253,487, 19.8.41. Appl. 27.2.40. Portable well-derrick base made of two portable sections. A. H. N.

Production.

1086.* Recent Developments Point to Wider Use of Casing Pumps. Anon. *Oil Gas J.*, 24.7.41, **40** (11), 50.—Advances in the quality of the rod-strings and in the operation of the pumping units extended the safe setting depth of the casing pumps, and this was increased by the introduction of the small-diameter casing pump. While it might be impossible to lift the desired volume of fluid with a 2-in. pump in 2½-in. tubing string, it was possible to lift it with a 2½- or 3-in. pump in a 5-in. casing string.

Study of this type of pumping has led to an interesting disclosure, but one which might be expected when the principles involved are considered. The smaller the diameter of the tube through which a fluid is flowing, the greater the losses due to friction. The pressure drop in a 2-in. pipe is seven times greater than that in a 3-in. pipe; a comparison of carrying capacities shows that a 4-in. pipe will carry 5·3 times as much fluid as will 2-in. pipe at the same pressure.

Operation of the casing-pump requires that the working barrel be packed off from the casing, so that the casing can be used for the fluid passage or production string. The casing pump is run in the well on the rod-string the same as an insert-type tubing

pump. There are several methods used for setting the packer, depending on the manufacture of the particular pump used. Garbutt rods or J-tools are provided for recovering the pump for repair of the valves. A. H. N.

1087.* California Truck-Mounted Unit Capable of Servicing 10,000-ft. Wells. T. P. Sanders. *Oil Gas J.*, 31.7.41, **40** (12), 162.—The derrick is of two-piece tubular construction. Both upper and lower sections are made of chrome-molybdenum alloy steel tubing electrically welded. The crown block is integral with the upper section. Both sections are tapered to obtain greater rigidity, and the bottom section has a built-in guide section on which the upper section is raised and lowered. The guide section acts as a brace, increasing the leg capacity and increasing torsional rigidity.

The derrick is raised and extended by a built-in mechanical device driven by the hoist-engine. Raising is accomplished with two large-diameter screws operating two internally lubricated bronze-alloy drive nuts which are ball-bearing mounted. This raising mechanism is irreversible except under power, so the tower cannot fall should a power failure occur while it is being raised. After the two telescoped sections have been raised to the vertical position the upper section is extended by means of a small winch (also driven by the hoist engine) which spools a wire rope to raise the upper section into position. The derrick can be locked in either the high or low position by means of a pawl-and-lug mechanism operated from the ground. Design is such that the load is transferred from the legs of the upper section to those of the lower section without bolting.

One of the first duties required of the new Shell unit was the lifting of a heavy drilling derrick with all machinery intact so that track-laying wheels could be placed under it for moving. The complete derrick-and-rig unit weighed 85 tons, and when the heavy side was lifted the load on the well-servicing derrick was 130,000 lbs. This operation, though spectacular, did not call for as much lifting power as is required for pulling large-diameter tubing from a deep well. A. H. N.

1088.* Repressure Plants Permit Oil Production, Otis Fields. H. F. Simons. *Oil Gas J.*, 7.8.41, **40** (13), 39.—The development of the Otis field is reviewed up to date, when it is entering the stage where gas recycling is being used. The original bottom-hole pressure in the reservoir was 1178 lb./sq. in. with a gauge pressure at the well-head of 1064 lb./sq. in. and the weight of the static gas column computed at 114 lb./sq. in. after being corrected for deviation. On 1st May, 1941, the bottom-hole pressure had declined to 660 lb./sq. in.

The original gas content of the reservoir was estimated to be 207,900,000,000 cu. ft. of gas. Original oil content was estimated to be 6,044,343 brl. at reservoir conditions and 5,912,577 brl. of stock-tank oil, of which 50% should be recovered. Up to 1st May, 1941, 99,200,000,000 cu. ft. of gas and 1,410,868 brl. of oil were produced, leaving approximately 108,700,000,000 cu. ft. of gas, of which 93,700,000,000 should be recovered; total oil recovery on that date was 1,410,868 brl., leaving approximately 1,545,420 brl. to be produced. The estimate of recoverable gas is based on no venting of the gas produced with the oil and an abandonment pressure of 50 lb./sq. in.

Total pipe-line sales of gas on 1st May, 1941, amounted to 64,000,000,000 cu. ft., measured at 16·4 lb./sq. in. and 60° F. Another 6,100,000,000 cu. ft. had been used to that time in plant and well operation, and 29,100,000,000 cu. ft. has been vented by the combination wells. If the practice of venting were continued, an additional 43,100,000,000 cu. ft. would be consumed uselessly and the future recovery of gas reduced to 50,600,000,000 cu. ft. Gas–oil ratio has been approximately 20,900 cu. ft./brl.

With such a high gas–oil ratio the production of 1,410,868 brl. of oil resulted in the voiding of reservoir space equal in volume to 66,400,800 brl. In other words, 13·83% of the original gas content in the reservoir has been employed in producing a volume of oil which originally occupied only 0·3% of the total reservoir space. Further interesting data are recorded.

The plants used are solely for repressuring, and include no equipment for gasoline recovery. These are briefly described and illustrated. A. H. N.

1089.* East Texas Makes Progress in Hydraulic Oil-Well Pumping. G. Weber. *Oil Gas J.*, 14.8.41, **40** (14), 44.—The hydraulic pumping system substitutes hydraulic

power-transmission for mechanical methods in energizing subsurface well-pumps. The subsurface production unit—an engine-driven, double-acting, reciprocating, bottom-hole pump—is connected by a hydraulic power-line with the surface power source, consisting of a triplex pump driven by a conventional prime mover. The triplex pump takes suction from the lease-tank of clean crude oil, discharging it to the power-line. At high pressure the fluid is moved to the production unit or subsurface engine, returning to the surface with the fluid which it has served to lift.

As a rule, the surface unit is located near the lease-tank battery. By thus obviating the necessity for the operator to visit individual wells, much time is saved in pumping a lease. On multiple-well leases the power-oil from the triplex pump is discharged to a header at pressures ranging from 700 to 1500 lb./sq. in. Individual power-lines to all wells in the system are connected to this header. On some units each line is equipped with two valves: a block-valve for use in shutting down and starting the well pump, and, down-stream from the block valve, a metering valve. The metering valve is set to admit power-oil to each well in the quantity required to lift its allowable together with salt water in a fixed production period. Such valve-settings remain fixed until increased salt water withdrawals require their resetting. Thus an entire lease can be pumped during a certain period each day. On some leases a small measuring tank is installed to allow the checking of water and oil percentages from individual wells. This periodic check aids in maintaining full allowable production from each well in the system.

Pump-strokes can readily be counted by observing the slight fluctuations of the gauge-needle on each power-line at the surface unit. This allows a constant check on pump performance. Well conditions, such as froth, pump-off, and erratic pump performance due to possible clogging or binding, can be noted at the surface unit, and necessary steps can immediately be taken to correct such conditions with minimum service cost and loss of production. Approximate bottom-hole pressures can also be determined from these manifold gauges. A. H. N.

1090.* Preliminary Examination of the Possibilities of Flooding Old Burbank, Oklahoma, Field. R. L. Ginter. *Oil Gas J.*, 14.8.41, **40** (14), 56.—In studying the possibilities for increasing production in the old Burbank field, Oklahoma, by water-flooding methods, data have been procured and calculations made which are of significance at this time, when consideration is being given to applying this secondary method in Oklahoma to deeper horizons than are exploited in the Nowata area. For the last five years water-flooding in Oklahoma has been largely concentrated in the Nowata field of Nowata and Rogers Counties in the north-eastern part of the State, where oil has been produced for thirty-five years from a sand body at depths between 450 and 550 ft. In looking for areas where water-flooding may be applied profitably, the opportunity for applying this method in the old Burbank field has been examined. This field, which is about 60 miles north-west of Nowata, was opened for development in 1922, and produces from depths of approximately 2700 ft. Results of studying this field to determine what can be accomplished by water-flooding are presented.
A. H. N.

1091.* Complete Tedious Workover Job in Deep Well on Gulf Coast. N. Williams. *Oil Gas J.*, 21.8.41, **40** (15), 49—50.—An unusually tedious and exacting deep-well work-over job, involving an attempt to restore production from a horizon in which the well had ceased flowing prematurely due to salt-water head, was recently completed by one of the major companies in the Old Ocean field, Brazoria County, Texas. Although the attempt was unsuccessful, efforts of the operators were rewarded when the well was eventually completed as a good producer in a slightly shallower deep sand.

The well was originally completed last January in a sand horizon topped at 10,132 ft., where 7-in. casing, cemented at 10,889-ft., was perforated. The hole had been drilled to a total depth of 10,990 ft. On potential gage the well flowed at the rate of 485 brl. daily through a $\frac{1}{4}$-in. choke. Recoverable reserves of the well were estimated at that time to be approximately 250,000 brl., but only 20,000 brl. of this had been produced when the well went dead. The work-over job is detailed. A. H. N.

1092.* Electric Pumping Units Gaining Favour in West Virginia Fields. H. S. Brubaker. *Oil Gas J.*, 21.8.41, **40** (15), 52.—Electric pumping units have many advantages over the older methods. Some of these are: (1) lower first cost; (2) minimum of maintenance; (3) uniform daily pumping, if desired seven days a week or several times a day, if necessary; (4) can be operated automatically with time switches and do not require attention more than once a week; (5) conservation of natural gas which can be sold to gas companies or used for repressuring when necessary; (6) require no cooling water in their operation, hence no freezing troubles in the winter.

The average oil-well pumper is paid about $125/month and is given charge of from five to seven wells, so that the labour item alone on gas-engine pumping is from $18 to $25/month. With the present wage-and-hour law in effect, pumping is frequently limited to 40 hr. a week, and very few companies pump on Sundays; however, the automatic electric unit will pump seven days/week, which gives an increase in oil production.

A. H. N.

1093.* Economics of Paraffin Removal by Electrical Heating. C. R. Rider and B. Turner. *Oil Gas J.*, 28.8.41, **40** (16), 40.—Operators in the Texas Panhandle using sucker-rod pumping equipment are, at present, utilizing five distinct methods to remove paraffin accumulations from the tubing. They are as follows: (1) *Steaming.*—In general, some operators steam down the tubing at regular intervals, whilst others use steam and hot water between the tubing and casing. (2) *Rod Scrapers.*—Scrapers are generally passed at 30-, 60-, or 90-day intervals, depending on the extent the well tends to "paraffin up." (3) *Chemicals.*—When chemical paraffin solvents are used, the usual practice is to pour a predetermined quantity into the tubing after the well has flowed off. (4) *Back-pressure Method.*—This method involves pumping against a back-pressure valve which is inserted in the lead line, generally near the well-head. (5) *Intermittent Electrical Heating.*—Basically, the method supplies heat to melt the paraffin in the tubing by passing a direct current through the tubing and rods, and using them as elements of a resistance heater. The tubing is insulated from the tubing head and casing by special insulation. At a point in the well below which paraffin is known to form, contact is made between the tubing and casing to complete the circuit to the surface. Heat is generated in the tubing and rods, rather than in the casing, because the former have a smaller metal area, with consequent higher resistance.

Current is supplied at the surface by a high-amperage, low-voltage generator. Contact is made to the well-head by means of removable cables, the tubing being used as the positive, and the casing being used as the negative terminal.

After applying the current to the tubing for a period varying between 1 and 2 hr., the generating truck is disconnected and the melted paraffin pumped out of the tubing. In addition to the five methods outlined as being used to remove paraffin accumulations, numerous variations and combinations of these methods have been tried and are being used. Obviously, wide differences in opinion exist among the various operators as to the most economical method of combating the paraffin problem.

Detailed costing shows the advantages of the electrical heating method.

A. H. N.

1094.* Gas Volume Determined With Portable Measuring Device. H. F. Simons. *Oil Gas J.*, 28.8.41, **40** (16), 50.—To facilitate the taking of volume and pressure tests on the wells on a repressuring operation in the Glenn Pool of Oklahoma, the engineers in charge designed and built a special tester. This includes the orifice, manometer, and spring gauge mounted so that all instruments can be connected on the producing wells and a reading obtained in less than 2 min. Orifice plates have been installed on the input wells, and it is only necessary to have the manometer and spring-gauge mounted for testing them.

A U-tube of copper pipe and flexible brass tubing 1 in. in diameter is used for directing the gas through the orifice and back into the line; the flexible tubing is used, as the spacing of the openings on the line bypass is not the same in all cases, and if a U-tube of pipe were employed it would place the connections in a strain. On the bottom of each end of the U are ¼ by 4-in. brass nipples and unions. The nipples are equipped with wings so that the connection can be made without the aid of a wrench.

The unions can also be made up by hand, and the only place a wrench is needed is in removing the steel-plugs from the tees in the bypass.

A 16-in. section of the 1-in. copper pipe is above the union on the inlet side and ahead of the orifice, which is held in a special union. One of the problems in designing the instrument was determining the shortest possible length of pipe to be used ahead of the orifice union and still have assurance of the accuracy of the readings. Copper tubing $\frac{1}{16}$ in. in diameter is employed for connecting to the manometer and the pressure gauge, and is soldered to prevent leaks.

To obtain a reading it is only necessary to remove 2 $\frac{1}{2}$-in. plugs from the by-pass on the flow-line, insert the connections on the assembled instrument, tighten them by hand, and close the stop-cock on the line so that the flow from the well is directed through the by-pass. It takes about 2 min. to get a test, and the engineer operating the instrument can walk and carry the instrument and gauge more than thirty wells per day. As there are eighty wells to be tested weekly, it is apparent that an efficient method is necessary if the engineer is to have any time for other work. A. H. N.

1095.* Water Flood Proves Successful in West Central Texas Pool. R. M. Sanford. *Oil Gas J.*, 28.8.41, **40** (16), 53.—West Central Texas, with its many shallow fields, ranging in depth from 200 to 1500 ft., offers one of the most promising secondary oil-recovery areas in the United States. Comparatively little secondary-recovery work has been done in the district, and practically no water-flooding has been undertaken. It is possible, however, that in future appreciable work will be undertaken along these lines.

An experimental tract in the old shallow Woodson field in Throckmorton County has responded favourably to water-flooding, and as a direct result five separate fields, comprising some 600 semi-depleted wells, are now being made ready for water-flood projects.

The field had produced approximately 3000 brl./acre up to the start of the water-flood six months ago. Core tests showed that about 500 brl. oil/acre-ft. were still remaining in the formation. The operators expect to recover about 60% of the remaining 500 brl./acre-ft. or about 4200 brl. oil/acre, based on an average pay thickness of 14 ft. This would make a total oil yield under both primary and secondary-recovery practices of 7200 brl./acre. These calculations and recoveries have been found applicable to the other projects being prepared for flooding; thus their ultimate recoveries will be about the same as this experimental flood project.

In December 1932 the total monthly oil production of the Woodson field was about 650 brl. In 1934 total field production had fallen to an average of 160 brl./month. From 1935 to 1940 the field was definitely in the stripper-well class and making an average of 120 brl. oil/month. The field production is now up to 1000 brl./month, and a total oil production of 1500 brl. is expected for August. This steady rise in monthly production is being obtained entirely from the 39-acre lease under flood, and a much greater increase is expected after the entire field is placed under flood.

The experimental flood has cost an average of \$750–1000/acre to water-flood some Oklahoma fields and \$3300/acre to flood the 1700-ft. fields of Pennsylvania.

A. H. N.

1096.* Co-operative Application of Modern Well Workover Programme Reduces High Gas–Oil Ratios Sharply. G. M. Wilson. *Oil Wkly*, 21.7.41, **102** (7), 20–23.—As the prorated per-well allotment of oil production for each well is based on the amount of gas produced along with each barrel of oil—5000 cu. ft. of gas/brl. being considered the maximum at the present time, and above which daily allotments are reduced proportionately—various methods have been employed in performing certain remedial work to shut off part of the gas, and thus reduce the gas–oil ratios of the penalized wells. By means of corrective work that had its inception in the latter part of 1937 through the co-operative work of the Goldsmith Pool Engineering Committee, and in the taking of more than ordinary precautions in completing subsequently drilled wells in the field, the average weighted gas–oil ratios have been brought down to approximately 1500 cu. ft./brl., with comparatively few wells now exceeding the 3000 cu. ft. ratio limit set by the field rules. This does not include a few wells in certain parts of the field that are classed as gas wells, and which do not produce any appreciable amount

of oil. Many wells the gas–oil ratios of which were as high as 50,000–100,000, with a few wells even exceeding this mark, have been subsequently worked over under the programme and brought down to below the penalty-free ratio of 5000.

Details of the programme are given. A. H. N.

1097.* Dehydration in High-Pressure Gas Operations as Applied to Repressuring and Pressure Maintenance. R. A. Carter. *Oil Wkly*, 21.7.41, **102** (7), 29.—*Paper Read Before Natural Gasoline Association of America.* Hydrate formation and its prevention are studied from the point of view of pressure maintenance and repressuring. Partial dehumidification is certainly the most reliable and trouble-free method of solving the hydrate problem, and two methods have been successfully employed. A method using a solid material such as activated alumina has given good results. This method is described and illustrated.

Methods using liquids, particularly ethylene glycol, are also detailed. The operating cost of either the activated alumina or liquid system is small when installed in a repressuring or pressure-maintenance plant. Generally no additional operating labour is required, and the make-up chemicals are almost negligible. The initial investment cost on either of these systems is, however, a substantial amount; but since each such installation is a separate problem, it is not practical to assert that one method is less costly than the other. For relatively small rates of flow, however, it has generally been found that the solid material, such as activated alumina for dehydration, is lower on investment cost; whilst for larger flows the liquid dehydration systems have the advantage for initial installation expenditure. A. H. N.

1098.* Proper Direction of Crank Rotation is Important. F. Swindell. *Oil Wkly*, 28.7.41, **102** (8), 46–47.—Most speed reducers are so designed that the driven sheave can be placed on either end of the high-speed shaft, so it is not surprising that many installations of this type are being operated with the crank rotating in the wrong direction. This may result in the use of from 3 to 10% more power than is necessary and in excessive bearing wear due to the induction of unnecessary friction. By the use of a simple rule anyone involved in this problem may determine the proper direction of rotation.

The rule for determining the proper direction can be stated thus: If the distance from the centre or saddle bearing to the upper pitman or tail bearing is the same or nearly the same as the distance between the centre line of the same post and the centre of the slow-speed shaft on the speed reducer, the unit should be operated in counter-clockwise or reverse motion; if the latter distance is much greater than the former, clockwise or forward motion should be used. It is suggested that it would be a good practice for all manufacturers of this type of equipment to specify the desired direction of rotation in their installation instructions. A. H. N.

1099.* Completion Costs Cut by Cleaning with Compressor. G. M. Wilson. *Oil Wkly*, 11.8.41, **102** (10), 17–18.—A method of cleaning out flowing wells during completion operations by use of a compressor is being used with good results and a definite saving in initial cost of the wells by one company operating in the Wilmington field of Southern California. A portable, low-volume, high-pressure compressor is used to remove mud, water, and dead oil from either the casing annulus or the tubing string, after which live oil and gas are allowed to enter from the formation.

The same procedure cannot be applied to every well, since many variable factors are involved. Production may be obtained in most parts of the field, from any one or several of four distinct zones. The method of completion, whether single or multiple zones, sizes of casing and flow-strings, gravity of the oil, and the anticipated rate of production in that particular part of the field based on wells in the same area all tend to influence the exact procedure to be followed, so each new well is treated almost as a special case. Oil gravities in this field vary from 14° to 26° A.P.I. in the Ranger and Upper Terminal, and between 26° and 31° in the Lower Terminal. The method is detailed.

Since the adoption of this extremely flexible system of cleaning up and putting the new wells on production, much less time is involved in cleaning up around the well; very little oil is sprayed up in the derrick, and the possibility of polluting the nearby harbour and tide-water drainage systems is greatly decreased. A. H. N.

1100.* Automatic Scrubbers and Multiple-well Metering Effect Saving. G. M. Wilson, *Oil Wkly*, 18.8.41, **102** (11), 17–18.—A new and successful method of automatically separating, desanding, metering, and moving crude oil through the gathering system to the lease shipping tanks is being used with economical and consistently good results by a company operating in the Wilmington field of Southern California. Of still greater interest is the fact that the production from more than one well may be continually metered into a common gathering-line system 24 hr./day through but a single registering meter and shipping pump. Centralized units of four wells each are in common use, whilst an eight-well unit is being designed and built for early installation.

Production in this field comes from both flowing and pumping wells, the oil gravities from the several zones varying between 14° and 31° A.P.I.

A typical unit consists of four producing wells that deliver the gross fluid into as many scrubbers grouped together at a convenient centralized location. Gas, water, and sand are separated out in the scrubbers. As the rising oil level in any particular scrubber reaches a certain height, a float automatically closes an electrical switch, which opens the oil-discharge line to the pump and starts the electric motor-driven centrifugal pump. As the oil leaves the pump it passes through a specially designed multiple-head registering meter, after which it passes out into the oil-gathering lines. A system of special solenoid and electric relay switches, mounted on a nearby switch-panel, regulates the order of emptying of each scrubber, and also makes it impossible for more than one to be discharged through the pump at the same time.

The method and apparatus are described in some detail, together with safety and other precautions. A. H. N.

1101.* Analysis of Lifting Performance in Natural-Flowing Wells. S. F. Shaw. *Oil Wkly*, 18.8.41, **102** (11), 21.—The flow of oil by virtue of gas energy is discussed in great detail in this comprehensive paper. The complexity of the problem is great even when compared with the difficult analysis of air-lift of water where the gas is nearly perfect and solubility complications do not exist to any great degree. After the well is opened to production, the variables that accompany the performance of a flowing well are as follows: Quantity of oil produced over a given period; quantity of gas produced; bottom-hole flowing pressure; and discharge pressure, or back pressure, at the tubing head. If the flow is through the tubing, and the fluid in the annular space has been displaced by gas to the bottom of the tubing string, close approximations of the flowing pressure can be ascertained by adding the weight of the column of gas to the casing pressure at the well-head, without the necessity of running a pressure-bomb. If any doubt exists as to flowing pressure being correct, a pressure-bomb should be run to obtain accurate pressure data.

In a well on natural flow, after the tubing is suspended in position the only changes that can be made in the flowing conditions that lie within reach of the operator are those of enlarging or reducing the size of the choke, which changes affect all four flowing conditions mentioned. Enlarging the choke usually results in the production of an increased quantity of oil and gas; the well-head discharge pressure, or back pressure, usually declines; the flowing pressure at the bottom of the tubing declines; and the casing pressure also declines, provided the annular space between the tubing and casing is free of liquid and that no packer has been set.

In natural flow, as in gas-lift flow, there are four principal rates of flow, as follows: (1) point of no flow, due to insufficient gas being present to lift the oil above the top of the eductor; (2) the rate of maximum efficiency or rate of minimum output factor; (3) the rate of maximum capacity, or rate of minimum flowing pressure; (4) the point of no flow caused by excessive quantity of gas.

The rate of no flow due to insufficient quantity of gas is, as a rule, of theoretical importance only, and for natural flow need not be considered. The rate of maximum efficiency is one of considerable importance, but lies in the region of production where there is surging in the flow column, therefore it cannot easily and satisfactorily be located directly by tests, except to plot the tests and locate the point on the flow-graph. The rate of maximum capacity is probably the easiest of all significant rates to locate, and in many respects is the most important rate to determine in gas-lift operations. There are, of course, innumerable other rates of flow, but such rates are at the expense either of efficiency or of capacity, and have little significance in connection with oil-well testing operations. After stressing the need for accuracy in measur-

ing the variables, the paper discusses actual well studies under conditions where no back pressure is imposed and where such pressures are used.

In wells where the reservoir rock is of a low degree of permeability, much care must be exercised when opening the choke for the purpose of obtaining higher flowing rates, otherwise the well may unload to the point where the gas in the casing flows out through the tubing, reducing the flowing pressure to a low point, and afterwards allows considerable oil or water to rush into the well and load it up, during which time there will be no flow from the eductor, and the well may then run for a long time in heads or refuse to flow at all. Such changes must be made gradually, to prevent heading action. A. H. N.

1102.* Time Switches Control Periodic Pumping of Marginal and Prorated Wells. G. M. Wilson. *Oil Wkly*, 25.8.41, **102** (12), 17–20.—Through installation of electric time-switches, which automatically start and stop pumping operations at predetermined intervals suitable to individual well characteristics, the mechanical difficulties usually associated with continued operation of marginal wells after they have been pumped off are being avoided, and prorated wells are being shut down on producing their daily allowable, or started when desired without manual attention. By relieving the pumper of these starting and stopping duties, he is given additional time to cover his territory and properly service a greater number of wells. Thus, less frequent pulling of jobs and appreciable reductions in other lease expense are resulting.

When fluid level is at or near the pump intake, free gas has a tendency to by-pass the fluid as the latter enters the pump-barrel, usually resulting in the cutting and scoring of the balls and seats. Pump-barrels sand up much easier (if the well produces from a sand formation), and because the travelling valve "pounds fluid" on each down-stroke, emulsion troubles usually result.

The time-clock, containing a mechanism which trips a switch at any desired number of points around the face of a clock-dial, is contained in a small metal box which is bolted beside the standard supporting the main pump-switch. As the hand on the clock makes contact with one of the predetermined points, it closes an electric circuit energizing the magnetic switch in the main switch-box, thus starting or stopping the pump-motor. It is possible to operate the switch manually should it be necessary at any time.

Many wells that have been equipped with this automatic system have actually begun to show a slightly higher daily rate of production than previously. When a formation is producing fluid at as nearly a constant rate as possible, thus maintaining a more or less constant differential pressure between the sand-face and the well-bore, the movement of oil and gas towards the well from back in the formation will proceed at a more nearly uniform rate. Any tendency for the gas to by-pass the oil in the sand interstices, especially in fields troubled with higher-than-normal gas–oil ratios, will thus be minimized, resulting in a more efficient use of the driving energy of the gas. A. H. N.

1103.* Flow of Distillate Wells Requires More Complicated Equipment and More Careful Handling than Oil. E. Sterrett. *Oil Wkly*, 25.8.41, **102** (12), 22–23.—Equipment for successfully producing a distillate well is much more complicated than that which will handle, for example, an East Texas field oil-producer. Added equipment and more delicate adjustments to maintain the desired pressure, temperature, and flow balances impose on the switcher duties which require close supervision, and, in consequence, the number of such wells which one man can flow is limited both by the attention required and the fact that distillate wells are usually wide-spaced.

One well, for example, producing from the Paluxy in the Chapel Hill field, under proration regulation, can make more than 5000 brl. of distillate/month, and furnish upwards of 15,000,000 cu. ft. of dry gas.

To secure this flow, the switcher must watch six sets of equipment, each adjustable to deliver required amounts, and each governing its successor and being dependent on its predecessor in the production line for proper functioning.

The flow equipment of this particular well is described in some detail and illustrated photographically. A. H. N.

1104.* Portable Concrete Forms Asset When Multiple Foundations Are Poured. Anon. *Oil Wkly*, 25.8.41, **102** (12), 26.—Locating and levelling forms for concrete bases for heavy engines and pumps must be carefully planned and carried out, if the eventual setting of the power units is to present the mathematically exact line which is evident in the well-planned and set-up power plant. With stations depending on internal-combustion units the number may amount to a dozen or more, greatly increasing the chance of one form slipping or drifting slightly and thus forcing the corresponding engine base a trifle out of alignment with the others.

The paper describes an ingenious method used for putting down concrete bases for twelve 600-h.p. 12-cylinder gas-engine compressor units, the method resulting in the casting of all bases in a continuous structure with the desired precision.

The forms were built up as four separate panels, each composing one side of the completed unit, and fitted together rigidly at the corners with accurate dovetailing to maintain sharp, clearcut foundation corners. The separate panels, assembled into a form at a site just back of the location of an engine unit, were designed with brackets on alternate vertical braces of the two transverse sides, through which heavy beams were run and securely fastened. These arms or handles extended 5 ft. in each direction beyond the corners of the structure. A. H. N.

1105.* Suggested Method of Measuring Input Profile of Intake Wells. E. P. Bowler. *Oil Wkly*, 1.9.41, **102** (13), 25.—The method of measuring the input profile of a well as outlined in this paper was developed in an attempt to give the producer a practical and economical method by which he might determine the exact amount of water entering each succeeding portion of his sand-body. An exact replica of the field conditions as illustrated in this paper has been developed in a laboratory set-up, and each principle explained herewith has been tried and found to be both theoretically and practically sound in so far as this model arrangement is concerned.

The principle on which this method is based is the use of two immiscible fluids such as water and crude oil. It consists essentially of lowering a string of pipe inside the water-well tubing until the lower end of the pipe extends down into the pocket below the bottom of the sand. The lower end of the pipe is open. At the surface the top of the string of pipe is connected to the water-line and the well is allowed to maintain its normal input/day through the inner string. The 2- or 1½-in. water-well tubing at the well-head is now connected to a high-pressure, low-capacity pump, which in turn is connected to a crude-oil supply.

For simplicity it is assumed that the well is tubed with 2-in. seamless pipe anchored with a hook-wall packer which is cemented a short distance above the top of the sand. The well has 24 ft. of sand. The inner string consists of 1-in. pipe lowered through the 2-in. tubing, and allowed to extend into the pocket below the bottom of the sand. At the beginning of the experiment the water is injected into the entire sand-body and a measurement taken of the rate of input on the flow-meter arrangement in the water-line. This would represent normal intake/day for the well. A pressure in excess of the water-line pressure is now built up at the oil-pump, and the oil is allowed to flow into the well through the annular space between the well-tubing and the inner string, impressing itself on top of the water. The oil–water contact level is maintained successfully at 1, 2, 3, etc., ft. below the top of the sand, and the rate of water intake is measured. The oil flows into the sand and acts as a packer for the portion of the sand it covers, in so far as the water is concerned. Thus, the effective permeability of the sand to water is measured foot by foot.

The contact level is determined by means of passing current under constant voltage through the fluid occupying the space between two electrodes. As the oil travels downwards, the resistance increases. An ameter at the surface thus indicates the level which can be accurately maintained by manipulating the oil-valve.

The paper is detailed in treatment and well illustrated. A. H. N.

1106.* Throttle Control of Pumping Engines. F. Swindell. *Oil Wkly*, 1.9.41, **102** (13), 40.—It is pointed out that when the flow of power is irregular under governor operation, it can usually be made much smoother by the use of a set throttle. Many engines when delivered are not equipped with an arrangement for dependably setting the throttle, but in these cases a device can be installed easily and cheaply.

The workings of a governor control are described.

In throttle operation the governor is set at some point above the maximum speed that the engine will develop under normal operating conditions. Usually, this should not be over 50 r.p.m., depending on the sensitiveness of the governor. For instance, if the maximum speed is 1000 r.p.m., then the governor is set at 1050 r.p.m. With the well pumping under normal conditions the throttle is then set to permit only that amount of fuel which will enable the engine to run at 1000 r.p.m. Care should be taken that the well is fully pumped up when the throttle is adjusted. With this condition obtaining, if the sucker-rods should part, or any other of the equipment should break, so that the load on the engine is materially reduced, its speed will increase until it reaches 1050 r.p.m., at which speed it operates against the governor until such time as the switch is turned off or the fuel supply becomes exhausted. Thus, the safety provision of the governor is available under throttle operation.

A graph presents the results of a field study of governor-*versus*-throttle operation wherein the prime mover was a 4-cylinder gas engine; the well was equipped with ¾-in. rods and a 2½-in. insert-type pump set at approximately 4600 ft. All operating conditions, as nearly as could be observed, remained the same throughout the study, except for the changing from governor to throttle operation. One test was made immediately after the other, and all the work was completed within a few hours. Both the speed and the h.p. graphs show definite advantages obtained with throttle control. The fluctuations and maximum values were less in the latter case.

A. H. N.

1107.* Cycling Plant in Swamp Area Permits Profitable Operation of Isolated Wells. F. H. Love. *Petrol. Engr*, August 1941, **12** (12), 29–30.—The plant is small, having but one compressor and handling only 8,000,000 cu. ft. of gas/day. Two producing wells (whose depths exceed 10,000 ft.) are connected to the plant, and gas is returned to a single injection well. The output of the plant, which operates on the straight retrograde separation principle, is approximately 200 brl. of condensate/day.

The plant and injection well are on the west side of the Atachafalaya River, and the producing wells are on the east side, about 600 ft. distant. Lines from the wells to the plant pass through the river, and during cold weather, when the river-water temperature falls to as low as 49° F., it is necessary to heat the gas before it enters the river and again when it emerges on the other side, to prevent hydrate formation. Immediately before entering the river the gas-streams from the two producing wells merge in a common line and pass through a water-bath-type heater. On the west side of the river, which is the side nearest the plant, the gas-flow passes through a second heater of the same type. The first unit heats the gas to a temperature of 110° F. By the time the gas reaches the west side of the river this temperature has been reduced to about 80° F. and in the second heater this in increased to 100–105° F. Certain details of the plant are given.

A. H. N.

1108.* Essential Factors in Planning Paraffin Solvent Treatments. G. F. Williams. *Petrol. Engr*, August 1941, **12** (12), 93.—It was observed that debris taken from the mud anchors of pumping wells contained carbonate scale particles cemented together by paraffin. These wells responded to a slight degree by washing out with salt water. Further, it was found that they could be filled with oil or water, a condition not normal in old, partly depleted pumping wells. As time passed, the wells made less and less fluid, although wells of this area were usually prone to increase in salt-water production as daily oil output decreased.

With the foregoing facts in mind, the theory was developed that the proper paraffin solvent spotted on the face of the pay would dissolve at least one part of the plugging agent on or near the sand-face. Any oil increase here would prove that progress was being made in solving the problem economically.

A pumping well was first selected because the carbonate scale had been removed already by a commercial scale-removing chemical treatment, resulting in a production increase of from 5 to 70 brl./day. This scale was known to contain paraffin as an additional plugging material.

In making the paraffin removal treatment, 50 gal. of commercial paraffin solvent was pumped into the casing using a low-pressure pump, followed in this particular

case with the casing volume of water. The water was lighter than the solvent, but heavier than the oil. The tubing with rods in place remained open during the treatment, but the tubing and casing were both closed-in overnight after the application of the solvent. The well was put on the pump the following morning, and averaged 100 brl. daily for the next 30 days, an increase of 30 brl./day, attributable to the solvent treatment. The total increase in production in the 30-day period was 900 brl. The approximate cost of the entire treatment was $75 for solvent plus $25 for labour. Other cases are given in detail.

Generally speaking, in making treatments such as those described, the following points should be remembered: (1) In order for a treatment to be successful, the well's flow must be impeded by paraffin; (2) the paraffin must be soluble in the particular solvent used; (3) in making a treatment, a considerable quantity of oil must be used in flushing down the solvent—for this purpose operators have been using oil from the identical well being treated; (4) when the circulation method of treatment is being used, a sufficient circulating time, generally 12–24 hr., should be allowed. A. H. N.

1109.* Design and Installation of Hydraulic Well-pumping System. H. L. Flood. *Petrol. Engr*, August 1941, **12** (12), 102.—Essentially, an hydraulic pumping system consists of two major parts: (1) the surface, or hydraulic power unit supplying clean power oil to (2) the subsurface, or production unit. The power-unit pumps clean crude oil down the well under sufficient pressure to operate the production unit, which consists of an hydraulic reciprocating engine directly connected to a reciprocating pump. The production unit is usually run as an insert pump, seating in a shoe in the well-tubing in the conventional manner. The tubing on which the pump is run serves to conduct the power oil from the surface to the subsurface unit, and is termed the power-oil tubing. The discharged power-fluid mixes with the crude oil produced from the formation, and is returned to the surface in the annular space between the power-oil and well-tubing strings.

The paper details the actual designing undertaken in a specific case, giving the major considerations taken into account.

The fluid produced from the wells, including the spent power-oil, is gathered and delivered to the central plant through the gathering system already serving the wells prior to the pumping installations. The total volume of fluid produced first enters the elevated gas-oil separator. The fluid, after the gas is separated, gravitates to the base of the vertical gun-barrel, containing 6 ft. of water, through which the oil is washed as it passes upward in the tank. Additional gas coming out of solution in the gun-barrel is removed through the outside gas separator or boot.

Only that quantity of the oil produced which is required to supply the power-unit enters the horizontal settling-tank from the vertical gun-barrel; the remainder passes directly to the stock-tanks. Thus, only a relatively small volume of the total oil is subjected to conditioning as power-oil. The effective settling time in such a large vessel as the horizontal tank is thus materially increased.

The inlet to the settling-tank is perpendicular to the axis of the tank on top at one end of the tank, and the outlet or suction line to the triplex pumps is at the other end, 2 ft. from the top, and parallel to the tank axis. Consequently, the oil enters the tank in a downward direction, then has its flow altered to horizontal, and is withdrawn 2 ft. from the top on the other end. A. H. N.

1110.* Air-Cooling in Pressure Maintenance Plants. E. O. Bennett. *Petrol. Engr*, August 1941, **12** (12), 124.—Good clean water, free from sediment and chemicals that will deposit in engine-jackets under normal operating temperatures, is absolutely essential for continuous trouble-free operation of large gas-engines. In some locations where compressor plants have been built during the last two or three years no water is available. Some of these locations are in hot, dry areas in which the normal mid-summer temperatures rise above 100° F. and the humidity is very low.

Evaporative-type coolers work well at such locations and do an efficient job of jacket cooling; but losses due to windage and evaporation may make their use uneconomical, and a system in which water losses are minimum must be used. Such a system naturally suggests that the jacket-water be circulated in a closed system and that atmosphere be used to remove heat from the closed system. In its simplest form this is known as radiator cooling.

Such an installation is described. Three coolers are connected in parallel between intake and discharge headers, and serve to cool the engine and compressor jacket-water from two 400-h.p., direct-connected, gas-engine-driven compressor units.

An unusual feature of these cooling units is that the engine lubricating oil as well as the jacket-water is cooled by the same propeller fan in each unit. The air is pushed by the fan through a water-cooling section 8 ft × 8 ft. and about 3 in. thick. Immediately in front of the water-cooling section there is an 8 ft. × 8 ft × 1½ in. section for the engine lubricating oil.

The engine jacket-water circulates through a closed system, and the water is treated for corrosion with an inhibitor. These units have now been running for 2 years, and the jackets have been entirely free of scale or corrosion. The 800-h.p. cooling sections require less than 1 gal./week of make-up water, and have satisfactorily handled the cooling in the hottest weather yet encountered. A. H. N.

1111.* Directional Drainage. S. C. Herold. *Petrol. World*, July 1941, **37** (7), 46.—The ease of decreasing or increasing diagonal flow up the structure where the sands are fairly homogeneous laterally and unbroken by faults depends almost entirely on the pattern of well locations at depth and on the allocation of production at various wells. The existence of a gas-cap on the crest of the structure facilitates this control of diagonal flow by preventing drainage from the opposite side of the structure over the top of the fold.

In order to illustrate diagonal flow, the simple case of two groups of wells located on more or less the same structural contour at some short distance apart can be cited. Such groups will not only pull the fluids directly up the structure, but will also pull from the converging diagonal direction down the structure. The latter will cause more rapid encroachment of edge-water in those directions, for both groups are taking fluids from properties located there. Any wells which happen to be located on those properties will lend to this encroachment. Edge-water will appear there sooner than on properties immediately below the groups. This circumstance has frequently been noted in practice in the fields of California.

Again, if eight of sixteen wells are evenly spaced over 160 acres, and if each is allowed its maximum of 150 brl. of oil, diagonal drainage can be enhanced by confining the total allowable amount to one or more of the wells at one side or in one corner of the area. Co-operation with another area at some short distance away will establish the situation of the two groups previously cited.

Where the productive sands are heterogeneous laterally, or broken by faults, controlling directional drainage is restricted. A. H. N.

1112.* Cotton Valley Project. Anon. *Refiner*, August 1941, **20** (8), 317.—A descriptive and pictorial record is presented of the Cotton Valley project in an extensive feature of the present issue of the *Refiner*. Recycling at Cotton Valley is the outgrowth of an agreement between operators and royalty owners. The agreement in turn was incorporated in an order of the Louisiana Department of Conservation. Thus the sands below the base of the Travis Peak formation were unitized for production. The plant serves for maintaining pressure and for recovering condensible liquids from the D and Bodcaw sands. Other sands which may become productive within the formations included in the agreement will also be operated under unitization.

For operating purposes the deeper sands have ceased to have production by leases of ownership. This has come under the management of the Cotton Valley Operators' Committee, which built and operates the plant.

Participation in the agreement is on an acreage basis. The owner of a lease shares in expense and profit in whatever ratio his acreage total bears to the area under the agreement. Cost of the plant was prorated on this basis. Likewise royalty owners will share in return in whatever ratio their surface holdings bear to the total surface within the unit.

Thus the total content of two distillate-bearing sands became available for recovery through one plant and under a common operation. Output is taken from wells as dictated by engineering studies rather than by lease lines. After recovery of liquids the gas is put back in the two formations in wells that offer the most advantageous means of maintaining pressure.

Content of the deeper sands at Cotton Valley is within the retrograde range, wherein all hydrocarbons are in the vapour stage. Condensation therefore takes place upon reduction of pressure. Conventional production methods whereby wells are flowed into separators, which prevailed in the field from 1937 until 1941, results in condensation within the reservoir, since withdrawal of gas brings consequent reduction of pressure within the reservoir.

Original liquid content of the two sands was estimated at 47,000,000 brl. of distillate. The period during which wells were produced without maintenance of pressure is calculated to have resulted in 14,000,000 brl. of this total being lost, since pressure maintenance is not calculated to restore the original reservoir pressure.

One other sand is known to hold content similar to the two now under development. Additional sands are considered likely sources of similar hydrocarbon content. In addition to distillate-bearing gas from the two deep sands, the recycling plant takes casing-head gas from the series of rim wells, which are classed as oil producers and not included in the unit agreement. This gas is part of the daily sales for commercial use. A. H. N.

1113.* What Shall be Done About Proration? Part II. O. W. Willcox. *World Petrol.*, August 1941, **12** (8), 36–41.—The purpose of this series of articles is to acquaint the petroleum industry of the United States with developments which show the ultimate form which may be given to a system of industrial proration, with limitation and control of production in the interest of both the industry and the general public welfare.

In a fully developed system of industrial proration there is no such thing as a marginal producer who is in danger of becoming submarginal when prices swing downward, because his colleagues and his Government (with the public approving) join hands to keep him afloat by means of special concessions.

The first and most important task confronting an industry that meets in plenary conference to devise a nation-wide, all-inclusive system of proration is to divide the business on a basis that will not be arbitrary or discriminatory. The method adopted in most prorated sugar industries is the so-called peak-year scheme, according to which the highest annual tonnage production attained by a factory during its past history is taken as its rated capacity, and its relative share in the total production is computed on that basis. However, a strict application of this arithmetical proportion was generally found to be inconsistent with the two main objects that had to be achieved: a low fixed price to the consumer and preservation of the weaker members. As a way out it was generally decided to give to the weaker members certain preferences and concessions. It is extremely interesting and important to note the nature and extent of such concessions. Some relate to details peculiar to the sugar industry, but others are capable of broad application to any industry, including the petroleum industry, and are suggestive of a new order of social economics that is vastly different. These concessions range from granting the weak concerns exemptions from restrictions in production, loans for modernizing their equipment, relief from export obligations and transportation hardships, etc. Although the burden of these reliefs fall on the stronger concerns, it has been found to be to the advantage of these concerns in the long run as prices and markets are stabilized.

The paper details the working of a Central Sales Agency which regulates the industries' affairs. A. H. N.

1114.* Some Problems of Horizontal Steady Flow in Porous Media. M. P. O'Brien and J. A. Putnam. *Petrol. Tech.*, July 1941, A.I.M.M.E. Tech. Pub. No. 1349, 1–13.—Data on the physical and thermodynamic properties of hydrocarbons have become available during recent years. These are obtained under equilibrium conditions, and their application to flow problems involves the assumption that equilibrium exists during that flow. It is shown that by making the usual thermodynamic assumptions and employing existing data on permeability to two-phase flow, Darcy's law may be applied to obtain the flow characteristics for representative combinations of flowing medium and the geometry of the porous medium. The following cases are investigated numerically: isothermal flow of propane in a horizontal sand-filled channel; adiabatic flow in a horizontal porous medium; isothermal radial flow of a mixture of crude oil

and natural gas, and adiabatic flow with the other conditions the same as for the isothermal radial flow.

The numerical results are not directly applicable to field problems, but the methods are generally valid. The analysis seems to justify the practical conclusion that the flow of multi-component hydrocarbons in porous media is approximately, but not exactly, isothermal, and that deviations from isothermal conditions have a relatively small influence on the weight rate of flow. G. D. H.

1115. Patents on Production. T. M. Ragan. U.S.P. 2,245,712, 17.6.41. Appl. 13.6.39. Electrically controlled well-packer.

P. C. Norman. U.S.P. 2,245,870, 17.6.41. Appl. 28.3.39.—Method and apparatus for paraffin treatment in wells.

J. P. Ratigan. U.S.P. 2,245,938, 17.6.41. Appl. 20.11.36.—Sucker-rod elevators.

C. S. Crickmer. U.S.P. 2,245,963, 17.6.41. Appl. 5.2.40.—Tubing coupling.

W. L. Church. U.S.P. 2,246,416, 17.6.41. Appl. 25.7.38.—Well-pump with a venturi passage.

A. Boynton. U.S.P. 2,246,500, 24.6.41. Appl. 8.12.39.—Differential stage lift-flow device, bellows type.

B. S. Smith. U.S.P. 2,246,542, 24.6.41. Appl. 1.11.38.—Means and method of locating levels in wells.

O. M. Davis. U.S.P. 2,246,577, 24.6.41. Appl. 17.10.38.—Pump adapted to be inserted in a well.

S. M. Zandmer. U.S.P. 2,246,611, 24.6.41. Appl. 12.10.36.—Method of testing oil- and gas-wells to increase production.

A. D. Garrison. U.S.P. 2,246,725, 24.6.41. Appl. 10.6.38.—Treatment of oil-wells to convert water-wet sands into oil-wet sand.

A. D. Garrison. U.S.P. 2,246,726, 24.6.41. Appl. 28.10.39.—Treatment of oil-wells to increase production.

A. Nelson. U.S.P. 2,246,751, 24.6.41. Appl. 16.1.40.—Submersible motor for deep-well turbine-pumps.

H. C. Otis. U.S.P. 2,246,811, 24.6.41. Appl. 22.5.37.—Well-flowing device.

M. De Groote. U.S.P. 2,246,842, 24.6.41. Appl. 27.6.40.—Process for breaking petroleum emulsions.

L. T. Monson and W. W. Anderson. U.S.P. 2,246,856, 24.6.41. Appl. 26.11.40. —Process for resolving petroleum emulsions.

C. W. Fisher. U.S.P. 2,246,881, 24.6.41. Appl. 25.8.39.—Well-packer for bottom-hole packing purposes.

G. A. Humason and W. J. Clay. U.S.P. 2,247,023, 24.6.41. Appl. 23.9.38.— Universal flow-device for wells.

L. Davis. U.S.P. 2,247,188, 24.6.41. Appl. 3.10.40.—Screen and liner puller.

C. D. Wagner. U.S.P. 2,247,325, 24.6.41. Appl. 5.8.40.—Casing-pump assembly.

R. R. Turner. U.S.P. 2,247,564, 1.7.41. Appl. 18.7.38.—Coupling protector for a pump-rod.

C. F. Prutton. U.S.P. 2,248,028, 1.7.41. Appl. 9.6.38.—Treatment of wells to provide a perforated lining made of resin forced between casing and well-face.

B. Young. U.S.P. 2,248,211, 8.7.41. Appl. 25.2.39.—Well-tool with a packer on it.

W. R. McKay. U.S.P. 2,248,302, 8.7.41. Appl. 10.3.37.—Oil-well pump.

C. A. Rasmussen. U.S.P. 2,248,305, 8.7.41. Appl. 16.5.38.—Producing apparatus for oil-wells.

M. De Groote and A. F. Wirtel. U.S.P. 2,248,342, 8.7.41. Appl. 22.11.40.—Process for breaking petroleum emulsions.

S. J. Thomas. U.S.P. 2,248,834, 8.7.41. Appl. 22.1.40.—Sand-trap and filter for oil-wells.

T. S. Park. U.S.P. 2,248,894, 8.7.41. Appl. 27.11.39.—Sucker-rod guide placed in tubings.

A. Boynton. U.S.P. 2,248,949, 15.7.41. Appl. 31.1.39.—Differential-type pneumatic piston-pump.

A. Boynton. U.S.P. 2,248,950 and 2,248,951, 15.7.41. Both appl. 8.12.39.—Differential stage-lift flow-devices using valves on the side of tubings.

J. R. Gillbergh. U.S.P. 2,248,982, 15.7.41. Appl. 4.1.39.—Method and apparatus for determining the character and points of ingress of well-fluids.

H. J. Quintrell. U.S.P. 2,249,170, 15.7.41. Appl. 14.10.38.—Liner hanger with an anchor.

H. J. Quintrell. U.S.P. 2,249,171, 15.7.41. Appl. 19.12.39.—Bridging-plug packing-sleeve for oil-wells.

H. J. Quintrell. U.S.P. 2,249,172, 15.7.41. Appl. 19.12.39.—Circulation bridging-plug and a setting-tool.

A. Boynton. U.S.P. 2,250,464, 29.7.41. Appl. 8.12.39.—Differential stage-lift device for wells.

A. Boynton. U.S.P. 2,250,465, 29.7.41. Appl. 8.12.39.—Differential stage-lift flow device, velocity control.

P. G. Maugham. U.S.P. 2,250,642, 29.7.41. Appl. 6.11.40.—Transfer elevator for sucker-rods.

W. A. Rice. U.S.P. 2,250,775, 29.7.41. Appl. 15.8.39.—Apparatus for developing wells by means of a piston closing by-pass holes.

A. L. Crowder. U.S.P. 2,250,792, 29.7.41. Appl. 1.6.40.—Pump with a double-acting plunger.

W. J. Lumbert. U.S.P. 2,250,871, 29.7.41. Appl. 27.9.38.—Well-screen made of separate cylindrical sections with bevelled openings.

W. B. Reed. U.S.P. 2,251,290, 5.8.41. Appl. 2.7.38.—Bottom-hole hydropneumatic power unit.

C. M. Blair, Jr. U.S.P. 2,251,393, 5.8.41. Appl. 17.8.40.—Composition of matter and process for preventing water-in-oil emulsions resulting from acidization of calcareous oil-bearing strata.

C. A. Rasmussen. U.S.P. 2,251,421, 5.8.41. Appl. 13.3.39.—Flow apparatus for oil-wells.

O. C. Mays. U.S.P. 2,251,712, 5.8.41. Appl. 4.3.38.—Means for shooting oil-wells, consisting of a multiple container bomb, the containers having explosives to different degrees of strength.

A. L. Parker. U.S.P. 2,251,715, 2,251,716, 2,251,717, and 2,251,718, 5.8.41. Appl. 26.1.39, 20.3.39, 29.3.39, and 3.6.39, respectively.—Tube couplings of various types.

A. Arutunoff. U.S.P. 2,251,816, 5.8.41. Appl. 11.5.38.—Submersible electric motor for deep-well pumps.

F. H. Eckert. U.S.P. 2,251,868, 5.8.41. Appl. 13.1.40.—Pumping apparatus for wells.

A. W. Steenburg. U.S.P. 2,252,047, 12.8.41. Appl. 15.9.39.—Well-pumping system and apparatus.

S. T. Tschappat. U.S.P. 2,252,240, 12.8.41. Appl. 16.3.39.—Packing device around a well-tubing.

L. C. Miller. U.S.P. 2,252,270, 12.8.41. Appl. 5.11.38.—Perforating device for a well-casing.

C. H. Mathis. U.S.P. 2,252,271, 12.8.41. Appl. 20.5.40.—Product and process for plugging formations.

W. F. Hollister. U.S.P. 2,252,597, 12.8.41. Appl. 29.3.40.—Well-pump.

F. M. Hudson. U.S.P. 2,252,767, 19.8.41. Appl. 4.5.36.—Standing valve-puller.

A. J. Lageson. U.S.P. 2,252,773, 19.8.41. Appl. 25.8.38.—Pump for pitless wells.

E. B. Hall and A. L. Armentrout. U.S.P. 2,252,973, 19.8.41. Appl. 10.3.39.—Method for testing and producing the fluids of the earth formations encountered in wells.

L. H. Pierce. U.S.P. 2,253,046, 19.8.41. Appl. 9.11.40.—Discharge apparatus for pumps in wells.

A. Pranger. U.S.P. 2,253,092, 19.8.41. Appl. 22.6.37.—Packer.

E. E. Peake. U.S.P. 2,253,396, 19.8.41. Appl. 31.8.39.—Intermittent flow-device for oil well-tubing strings.

E. C. Tanner. U.S.P. 2,253,404, 19.8.41. Appl. 30.6.39.—Submersible electric motor.

G. H. Brodie. U.S.P. 2,253,415, 19.8.41. Appl. 8.9.39.—Means for centring tubular well-strings. A. H. N.

Transport and Storage.

1116.* Cathodic Method of Controlling Corrosion in Open-Tank Condensers. N. G. Miller. *Nat. Petrol. News*, 9.7.41, **33** (28), R. 222.—Since the corrosion of metal in contact with water is electrolytic in its action, corrosion can be prevented, theoretically, by maintaining the metal at a negative potential with respect to electrolyte solution. Promising results have been obtained in practice by inserting artificial anodes in, for instance, a condenser tank, making the element to be protected the cathode. Four installations in open-tank condensers are described, and the apparatus required and the economics of the process are discussed. H. G.

1117.* Calibrating Displacement Meters on Volatile-Liquid-Petroleum Fractions. E. W. Jacobson. *Oil Gas J.*, 19.6.41, **40** (6), 48.—The author describes, with diagrams, an apparatus, for the calibration of displacement meters on volatile-liquid-petroleum fractions, such that errors caused by evaporation, change in temperature, and entrainment of gases in the test liquid are eliminated. The necessity for an apparatus of this type is consequent on the need for using, as calibrating liquid, one similar to that which the displacement meter is designed to measure. The effect of calibration with liquids of different viscosities on the degree of accuracy is illustrated in a number of graphs.

The author also describes a simplified commercial type of prover which has been extensively used on a meter-testing programme at the Gulf research laboratory.

T. T. D.

1118.* Conclusions Based on A.P.I. Coating Tests. K. H. Logan. *Petrol. Engr.* March 1941, **12** (6), 100.—In 1940 the American Petroleum Institute concluded an investigation of protective coatings for pipe-lines, that involved forty-six combinations of materials under fifteen soil conditions, at a cost of $100,000, and lasting 10 years. The present article discusses the results, but in view of the large number of variables, only the outstanding features are dealt with. The A.P.I. final report classifies the coatings into six groups, according to physical type. These groups are: (1) cold applications, (2) enamels, (3) mastics, (4) shielded coatings, (5) reinforced coatings, (6) shielded reinforced coatings. The first group provided inadequate protection against severe soil conditions. One or more of the better coatings in each of the other groups are used to illustrate the relevant phenomena. Continual decreases in the insulating powers of the coatings are shown by condensed tables, and in another table an attempt is made to compare the effectiveness of the coatings in terms of the condition of the pipe. Another table illustrates the protective effects of inhibitive primers.

The main conclusions reached are that :—

(1) there is a continual decline in all coating efficiency with increasing age;

(2) various reasons prevent protection from being complete, even with the best coatings;

(3) therefore, instead of attempting to get complete protection by coating, the pipe-line owner would do better to apply a reasonably good coating and supplement it by means of cathodic protection. J. C.

1119.* Laboratory Tests of Cathodic Protection in Soils. W. R. Hill. *Petrol. Engr.* March 1941, **12** (6), 69.—The controversy concerning the electrical conditions required for the effective cathodic protection of metal structures in contact with soil, and the desire to obtain more complete data, prompted the S.O.C. of California to carry out a series of laboratory tests, under various conditions, with a large number of steel samples.

In designing the test-cell, etc., an attempt was made to eliminate the common errors, due to variations in current density, variation in soil moisture content, and so on.

The following four soils of widely differing corrosiveness were used :—

(1) a corrosive low-resistance clay from an alkali flat;
(2) a dry, high-resistance loam;
(3) a extremely corrosive clay;
(4) a typical loam.

The results obtained are illustrated graphically, by curves, of the effect of moisture content on soil resistivity, of corrosion rate against current density and of metal-to-soil potential readings taken during the runs.

Although the choice of a criterion for measuring the effectiveness of a cathodic protective installation is complicated by the effect of soil conditions, the data indicate an inverse relationship between soil resistivity and current density. J. C.

1120.* Electrical Examination of Coatings on Buried Pipe-lines. J. M. Pearson. *Petrol. Engr*, Midyear 1941, **12** (10), 82.—A description is given of an electrical method of determining the state of a coating on a buried pipe-line, and of locating the actual holes and the ends of coated sections. The method used consists of applying an A.C. current of 0·005–0·010 amp. at 1000 cycles per second from a microphone "hummer" or similar apparatus and locating the electrical leaks with an amplifier. The A.C. current is connected between the pipe and a ground rod 100 ft. away, all current returning to the pipe from the earth, either through holes in the coating, or as charging current via the electrical capacity, or between pipe and ground through the sound part of the coating. At holes in the coating the increased voltage drop in the soil is indicated by the amplifier which is carried along the line, producing a maximum tone. A generally poor coating is indicated by a high reading at right angles to the line, that over the line being low. On location of the leak, the pipe is uncovered, the amplifier grounded to earth, and the coating explored with the free end of the input wire. The conductivity of the coating is measured with the same apparatus, giving a general indication of the state of the coating. C. L. G.

1121.* Accurate Voltage Control is Feature of New Holiday Detector. D. E. Stearn. *Petrol. Engr*, Midyear 1941, **12** (10), 160.—Present types of holiday detectors for pipe-line examination are generally of the power unit, high-voltage generating unit, or exploring electrode type, and rely for the indication of the holiday on the noise or light produced by the discharge, which is frequently difficult to detect. There is usually no convenient method of measuring or controlling the applied voltage, there is usually a variable leak through the lengthy H.T. wire, there is no indication of the condition of the batteries, and the effectiveness of inspection depends entirely on the speed and alertness of the operators.

An instrument has now been designed—the Electronic Holiday detector—in which the discharge is energized sufficiently to cause a change in meter reading, extinguish a green light and illuminate a red light, ring a bell alarm, produce a registration on a counter, mark the location on the pipe, and perform any other electrically controllable action.

It utilizes a high-voltage generator of comparatively low va. capacity, yet high enough to maintain a few thousand volts between the exploring electrode and the pipe while supplying the current normally flowing in the high voltage inspection circuit. Thus the danger of shock or of carbonizing the coating is eliminated. The detector can be used for inspecting interior coatings or insulating coverings of low electrical resistance. In tests it located holidays previously overlooked by two crews with normal holiday detectors, the faults being largely at pieces of carbonized coating materials, at folds of one coating material over another at a different temperature, at thin spots or pits and bare spots produced by a dragging shoe in the coating lead. The results indicate the importance of wrapping the finished coating. The speed of testing is high, a 2000-ft. section being examined in 66 mins. by a crew of three, during which time 360 holidays were located. C. L. G.

Gas.

1122. Survey of Odorizing Practice in Gas Transmission. R. W. Parker. *Petrol. Engr*, Midyear 1941, **12** (10), 114.—A survey of gas odorization practice of the major natural gas companies was recently made and has now been analysed. 70% of the gas sold by distributing companies is odorized, the practice being generally regarded as essential and the expense as justified. The trend is to trunk-line installations rather than district odorizers, present equipment being regarded as satisfactory. The requirements of a satisfactory odorant are considered as: (1) harmless and non-toxic; (2) inexpensive; (3) non-fatiguing to sense of smell; (4) non-corrosive and insoluble in water; (5) no noticeable product of combustion; (6) penetrating odour similar to that of city gas, and (7) stability in transportation. The odorants in general use are Calodorant (mixture of hydrocarbons and an organic sulphur compound), Pentalarm (mainly amyl-mercaptan), and ethyl mercaptan. At the optimum rates of 2 gal. Calodorant or 1 lb. of Pentalarm per million cubic feet, the cost is less than $1.00 per million cu. ft. of gas. Distribution of odorant is by direct injection of which the main types are the lubricator, differential controlled, or pressure differential controlled, and the by-pass method, of which the main types are the diffusion wick and liquid seal. Control of odorant concentration is by colorimetric analysis using copper oleate, or by calibration or measurement of liquid or by-pass gas volumes. C. L. G.

1123.* Density of Natural Gases. M. B. Standing and D. L. Katz. *Petrol. Tech.*, July 1941, A.I.M.M.E. Tech. Pub. No. 1323, 1–10.—Pools with pressures of 7500 lb./in.^{2} and the use of pressure-maintenance and recycling plants have increased the need for gas density data for high pressures. The experimental technique is outlined whereby density data have been obtained on sixteen saturated hydrocarbon vapours in the range 35–250° F. and 1000–8220 lb./in.^{2} The data are tabulated and graphed.

The compressibility-factor chart for natural gases has been revised and extended to 10,000 lb./in.^{2} Relationships are presented by means of which the density of hydrocarbon gases containing more than 83% of combined methane and heptanes plus may be obtained from temperature, pressure, and gas gravity (air 1·0) directly.

The relatively large quantity of high-boiling constituents present in high-pressure vapours in equilibrium with crude oils makes it necessary to include in the analysis of the gas the molecular weight, density, and possibly boiling range of the heptanes and heavier fraction. G. D. H.

Cracking.

1124.* Rate of Cracking of Paraffin Wax. L. B. Bragg. *Industr. Engng Chem.*, 1941, **33**, 376.—Commercial paraffin wax of 122° F. (50° C.) melting point was cracked in a small-flow-type apparatus at temperatures of 788–900° F. (420–482° C.) and pressures of 490–1870 lb. per sq. in. gauge.

The reaction rate constants were corrected to give the initial cracking rate, and may be represented by the Arrhenius equation

$$\log k = \frac{E}{RT} + C$$

where $E = 64{\cdot}356$, $C = 16{\cdot}713$, and R = gas constant = 1·985. Pressure does not appear to have any effect on the rate of cracking within the pressure range used; the reaction may therefore be assumed to be unimolecular. H. E. T.

1125. Patents on Cracking. P. Subkow. U.S.P. 2,245,735, 17.6.41. Appl. 12.8.35.—In a process for simultaneous cracking and polymerization of hydrocarbons, a mixture of hydrocarbons within the gasoline range and hydrocarbons of four and less carbon atoms is heated to a temperature between 700° and 930° F. in the presence of a mixture of different catalysts. One of the catalysts is designed to promote reforming of hydrocarbons in the gasoline range, and the other is active to promote polymerization of hydrocarbons having less than four carbon atoms.

L. C. Huff. U.S.P. 2,246,592, 24.6.41. Appl. 5.7.35.—A conversion process which comprises subjecting a residual petroleum oil to cracking in a cracking zone and simultaneously cracking a recycle stock at higher temperatures and in a second cracking zone. Cracked products from both zones are discharged into a reduced pressure vaporizer and separated into vapours and a liquid residue. The vapours are then fractionated to condense the heavier fractions, and the liquid residue removed and reduced to an asphaltic material by further distillation. The condensate from this further distillation is contacted with the vapours undergoing fractionation as a refluxing medium, and the condensate and reflux condensate are thereby combined. The resultant condensate mixture is supplied to the second cracking zone as recycle stock.

K. Swartwood. U.S.P. 2,246,607, 24.6.41. Appl. 19.1.35.—Conversion of hydrocarbon oils by heating relatively clean reflux formed in the process to cracking temperature under pressure in a heating coil and discharging the products into a separating chamber. Heavy charging oil is introduced into the chamber and partly vaporized. The mixed materials are then separated into vapours and unvaporized oil, and the latter subjected to independently controlled cracking conditions. The resultant vapours are combined with commingled cracked vapours and charging oil vapours, and the whole subject to vapour phase cracking conditions in a third heating zone. Vapours of the last step are fractionated to condense heavier fractions, and the latter supplied to the first-named coil as reflux condensate. Finally the fractionated vapours are condensed.

W. J. Sweeney. U.S.P. 2,246,959, 24.6.41. Appl. 18.11.37.—Catalytic cracking of hydrocarbons to produce a motor fuel containing gasoline constituents. A liquid starting material consisting of gas oil containing gasoline constituents is used as a basis of the operation. All constituents boiling within the gasoline range are removed, so that the resulting uncracked gas oil has an initial boiling point between 450° and 478° F. The resulting gas-oil fraction is then converted in the presence of a catalyst to produce a motor fuel having a higher anti-knock value than a gasoline motor fuel produced under substantially the same conditions.

N. Menshih. U.S.P. 2,247,097, 24.6.41. Appl. 18.5.38.—Method of catalytically cracking hydrocarbon oils. The oil is first vaporized and intimately contacted with a pulverized siliceous catalyst dispersed in a normally gaseous stream. The mixture is maintained at cracking temperature for sufficiently long to effect cracking, and the catalyst afterwards separated from the cracked products.

A. E. Pew. U.S.P. 2,248,118, 8.7.41. Appl. 8.10.37.—Process for cracking the vapours of a mineral oil by heating to a temperature range within which no efficient cracking occurs except in the presence of a particular catalyst. The heated vapours are afterwards flowed through a mass of adsorptive catalytic material. While the oil vapours are so flowing, sufficient heat is applied to more than compensate for that adsorbed by the net endothermic cracking reaction, and the temperature of the oil vapours thus raised.

W. L. Benedict. U.S.P. 2,249,595, 15.7.41. Appl. 20.7.40.—Improvement in the catalytic cracking process for the treatment of higher-boiling hydrocarbons to produce substantial yields of high anti-knock gasoline. A reforming catalyst powder is mixed with a hydrocarbon oil comprising a major proportion of hydrocarbons boiling within the gasoline range, and the mixture subjected to reforming conditions of temperature and pressure. The reaction products are separated into a non-vaporous residue containing spent reforming catalyst, etc., and vaporous products. The non-vaporous residue is then withdrawn from the process, and the vaporous reaction products mixed with the higher boiling hydrocarbons and catalyst powder undergoing cracking treatment.

F. A. Howard. U.S.P. 2,251,571, 5.8.41. Appl. 19.10.37.—Method of cracking normally liquid hydrocarbons by preheating them to the desired cracking temperature and feeding the preheated hydrocarbons to a granular mass of catalyst. A mixture of light hydrocarbons, having a higher thermal stability than the normally liquid hydrocarbons, is also preheated to a temperature above the desired cracking temperature. Preheated light carbons are introduced into the catalyst mass at spaced points along the path of travel of the normally liquid hydrocarbons to supply heat and to maintain the desired extent of conversion without indirect heat exchange. The reaction products are finally removed from the catalyst mass and a hydrocarbon mixture boiling within the gasoline range recovered.

T. B. Prickett and G. S. Dunham. U.S.P. 2,252,729, 19.8.41. Appl. 25.1.38.—Production of low-boiling hydrocarbons from a composite hydrocarbon material of wide boiling range and containing a large proportion of heavy or unvaporizable components. The initial material is heated under conditions designed to retard effective cracking while effecting substantial vaporization. The partly vaporized material is passed into a separating zone, and liquids and vapours are separated. Unvaporized material is withdrawn from the zone and superheated, the superheated vapours being continuously passed to a conversion zone containing a solid adsorptive incombustible material and maintained under conditions designed to effect cracking of higher-boiling to lower-boiling hydrocarbons. Products from the conversion zone are then passed to a fractionating zone wherein desired low-boiling products are withdrawn as vapours. A higher-boiling liquid fraction is withdrawn and subjected to pyrolytic conversion. Those portions of the conversion which boil below 500° F. are passed into the fractionating zone. A small portion of liquid is then withdrawn having an initial boiling point higher than the end-point of the low-boiling products. Thereafter the liquid is sent to the top of the separator in order to control the boiling range of vapours passing to the catalytic conversion zone.

G. C. Connolly. U.S.P. 2,253,285, 19.8.41. Appl. 29.3.38.—Cracking hydrocarbon oil by passing it in contact with an adsorptive catalytic mass consisting principally of silica and alumina formed by acid treating a zeolite compound containing an exchangeable base in an amount suitable for use as a water softening agent.

H. B. M.

Hydrogenation.

1126. Nature of Oils Obtained from the Hydrogenation of a Few Typical Bituminous Coals. C. D. Le Claire. *J. Amer. chem. Soc.*, 1941, **63**, 343–351.—The belief that the benzene soluble and insoluble parts of Pittsburgh coal are similar in their essential chemical structure, and that the oils formed by their hydrogenation are chiefly polycyclic hydroaromatic hydrocarbons, is supported by evidence produced in this work. Pittsburgh, Pocahontas No. 3, High Splint, and Illinois No. 6 were studied in order to determine the dependence of the nature of the hydrogenation products on the rank and type of certain bituminous coals. The hydrogenations were carried out in the presence of Adkins catalyst at 350° C., a temperature that gave good yields of petroleum-ether soluble products and avoided extensive degradation of the hydrocarbon structures.

The lower-rank coal of high oxygen content gives on hydrogenation units which have, on an average, lower molecular weights than the units from higher rank coals of low oxygen content.

On hydrogenation, the extract and residue from the benzene extraction of coal give hydrocarbons which are similar in nature to those obtained from the hydrogenation of the unextracted oil.

The maximum yields of petroleum-ether-soluble products are obtained by hydrogenation of the medium-rank coals. T. C. G. T.

1127.* Coal Hydrogenation. E. Berl, H. Biebesheiner, and W. Koerber. *Industr. Engng Chem.*, 1941, **33**, 672.—This paper describes the results obtained on the hydrogenation of natural bituminous coals and wood charcoal, and the subsequent hydrogenation of bitumen and residual coal made from these natural bituminous coals by extraction with tetrahydronaphthalene under pressure at 250° C. The catalysts employed in the hydrogenations were iron oxide, iron, and iodine. H. E. T.

1128. Patent on Hydrogenation. H. Baehr. U.S.P. 2,247,465, 1.7.41. Appl. 22.12.38.—Dehydrogenation of aliphatic hydrocarbons of the paraffin series containing at least 2 but not more than 10 carbon atoms in the molecule and polymerization of at least part of the dehydrogenation products formed. The initial materials are heated to a temperature between 250° and 600° C., together with a coal, the reaction being carried out under a pressure of more than 25 atmospheres. H. B. M.

Polymerization.

1129. Patents on Polymerization and Alkylation. M. M. Holm. U.S.P. 2,245,038, 27.6.41. Appl. 14.10.40.—Improvement in the process of alkylation of isoparaffins with olefins by means of an acid alkylation catalyst. Two zones of reaction are maintained in series, and the concentration of isoparaffin to be alkylated kept at at least 50% by liquid volume of the hydrocarbon phase in the first zone. In this way a high degree of dispersion is effected between relatively immiscible acid alkylation catalyst and hydrocarbon phases.

P. Subkow. U.S.P. 2,245,733, 17.6.41. Appl. 12.8.35.—Process for reforming and polymerizing hydrocarbons. Hydrocarbons boiling within the gasoline range are passed in a restricted stream through a heated zone to a gasoline-reforming temperature. The resultant gaseous and vaporous mixture is then passed through a polymerizing zone maintained at a temperature lower than the reforming temperature. Finally the mixture is passed in a restricted stream through a heating zone, where it is reheated to a gasoline reforming temperature and reformed therein.

P. Subkow. U.S.P. 2,245,734, 17.6.41. Appl. 12.8.35.—Production of reformed and polymer gasoline by heating a mixture of hydrocarbons, including hydrocarbons in the gasoline range having an end-point not exceeding 650° F., to an elevated gasoline reforming temperature. The products of reforming are then cooled, and a vapour of reformed gasoline fractions is separated out at a temperature between 400° and 500° F. Normally gaseous hydrocarbons are next introduced into the vapour stream, and the mixture is passed through a polymerizing zone to produce polymer and reformed gasoline.

R. F. Ruthruff. U.S.P. 2,251,580, 5.8.41. Appl. 4.12.39.—Conversion of olefinic hydrocarbons into hydrocarbons of higher boiling point by polymerization. The olefinic hydrocarbons are contacted at high temperature with a catalyst consisting as an active ingredient of an adsorption complex of phosphoric acid on hydrous stannic oxide. H. B. M.

Synthetic Products.

1130. Patents on Synthetic Products. M. H. Arveson. U.S.P. 2,246,654, 24.6.41. Appl. 30.12.39.—The patent describes a method of effecting continuous catalytic conversion of hydrocarbons in an apparatus consisting of a number of catalyst tubes mounted in a reaction chamber. Certain of the tubes are kept full of catalyst while others are being emptied and filled with catalyst material. While each tube is emptied and filled the passage of vapours through it is prevented. Removal of the spent catalyst material is effected without interruption of the flow of hydrocarbon vapours, and the catalyst is introduced into the reaction zone equally without interruption of the flow of hydrocarbon vapours.

V. Bayerl. U.S.P. 2,247,594, 1.7.41. Appl. 5.7.39.—Process for the recovery of hydrocarbons from a gaseous mixture containing same and fixed gas. The mixture is passed through an adsorber for hydrocarbons, the unadsorbed fixed gas discharged, and the adsorbed hydrocarbons dispelled from the adsorber by means of steam. These are then compressed and condensed and the hydrocarbons recovered from the uncondensed portion of the expelled gas by passing through the adsorber. Importance of the invention lies in introducing the uncondensed portion of the expelled gas mixture into the adsorber with the steam before the beginning of the expulsion of adsorbed hydrocarbons from the adsorber.

C. L. Thomas. U.S.P. 2,249,584, 15.7.41. Appl. 30.1.39.—A hydrocarbon-oil conversion process which entails subjecting the oil, together with normally gaseous paraffins of at least 3 carbon atoms in the molecule, to catalytic dehydrogenation, to produce normally gaseous and normally liquid olefins. From the resultant products an olefinic gas and an olefinic liquid are separated, and the latter is then cracked to produce gasoline and additional gaseous olefins. These are then polymerized to form normally liquid hydrocarbons boiling in the gasoline range.

R. G. Garofalo. U.S.P. 2,250,991, 29.7.41. Appl. 24.4.37.—Preparation of high-molecular-weight hydrocarbons by mixing a heavy asphaltic fraction with a light hydrocarbon solvent at a temperature sufficient to dissolve substantially all the non-plastic oily fractions contained in the heavy asphaltic fraction, but to leave plastic and bituminous material as an undissolved fraction. The solution of non-plastic oily fraction is separated from the undissolved fraction, and the latter distilled without substantial oxidation. The plastic fraction is recovered as a distillate, and the bituminous material as a distillation residue. H. B. M.

Refining and Refinery Plant.

1131. Developments in Petroleum Refining Technology in the United States, 1914–19. A. J. Kraemer. *U.S. Bur. Mines. Information Circular*, No. 7172, June 1941.—This review of developments in petroleum refining in the United States from 1914 to 1919 is based on the somewhat scanty information found in the literature of that period. It concerns chiefly cracking processes, for, apart from these, little development was made in petroleum refining, operators being concerned for the most part in enlarging their plants and erecting new ones to meet the growing demand for petroleum products.

At the end of 1919 cracking was still in its infancy, although the desirability of decomposing hydrocarbons of high molecular weight to form compounds of lower molecular weight and greater volatility had long been recognized. At the beginning of 1914 the Burton cracking process was the only one in commercial operation, and continued to be the only successful one for six or seven years after its development.

It is estimated that in 1915 the output of gasoline by the Burton process amounted to 3 million brl. At first there was considerable opposition to cracked gasoline, but later it was realized that it functioned as well as the straight-run product.

Other cracking processes receiving attention at the time were the Rittman process, developed primarily to provide an additional source of benzene and toluene for the manufacture of munitions, and various aluminium chloride processes. Then followed the Cross cracking process and the Dubbs cracking process, the latter being apparently the only one employed during 1914 and 1919 and still in operation in the United States. H. B. M.

1132.* Mechanical Properties of Solids. E. N. Da C. Andrade. *Engineer*, 1941, **171** (4457 and 4458), 380–383, 394–395.—The strength of solids is examined in relation to crystal structure. Surface effects, the geometry of glide, strength of metal single crystals, evidence from X-rays, and polycrystalline metals are each dealt with in detail. J. G. W.

1133.* Controlling Water-Side Corrosion. N. Newton, W. H. Atwill, D. R. Johnson, C. N. Rhoades, V. L. Nealy, and J. T. Kemp. *Nat. Petrol. News*, 25.6.41, **33** (26), R. 194–R. 207.—A collection of papers read at the Symposium on Corrosion held in connection with the Midyear Meeting of the A.P.I.

Sulphuric Acid Treatment of Bicarbonate Waters to Prevent Scaling. N. Newton.—A method of treatment of cooling waters containing a high content of $CaHCO_3$ with H_2SO_4 is described. Acid is used at the rate of 4 lb. per 1000 gal., reducing the $CaHCO_3$ from 514 p.p.m. to 50 p.p.m. CO_2 is removed by blowing air through the treated water. The treatment prevented the formation of new scale and slowly removed old scale.

Water Circulated to Cooling Towers Treated with Chromate. W. H. Atwill.—$Na_2Cr_2O_7,2H_2O$ is added at the rate of 500 p.p.m. and NaOH in sufficient quantity to convert the dichromate into the normal chromate and give a *p*H of 8·0. Sodium hexametaphosphate is added in quantity to give a concentration of PO_4 of 5–10 p.p.m. The phosphate is said to increase the corrosion resistance of the chromate film.

A Deaerator Retards Corrosion by Removing Dissolved Gases. W. H. Atwill.—Water for cooling systems is passed through a system of trays in a tower maintained at low pressure, thereby removing dissolved gases. 98% removal of oxygen is claimed. Installation costs are said to be high but maintenance costs low. The process is claimed to have had a very marked effect in reducing cooler tube corrosion.

Chlorination Controls Bio-Fouling of Water. D. R. Johnson and C. N. Rhoades.—Where cooler water is drawn from open ponds with earth bottoms, fouling by biological growths may become serious. Efficient control is claimed to have been obtained by treating the water with chlorine at the rate of 43 lb. chlorine per 24 hr., water-flow being at the rate of 5000 g.p.m.

Cathodic Protection Prolongs Bundle Life. V. L. Nealy.—An installation for the cathodic protection of a shell-and-tube condenser of the two-pass type is described. Steel plates supported on steel rods form the anodes, which are disposed between the tubes. Direct current is obtained from a motor generator supplying 1·75 amps. at voltages adjusted to the salinity of the water. Each condenser is earthed separately.

Corrosion Classified by Visible Effects. J. T. Kemp.—An illustrated article amply described by the title. H. G.

1134.* Use of Demulsifying Agents in Acidizing Oil Wells. J. B. Stone and L. L. Burge. *Oil Gas J.*, 19.6.41, **40** (6), 43.—The only economical way of combating emulsion formation in the acidizing of wells is by the addition of "demulsifiers" to deal with the trouble *in situ*. The agent is usually added either to the acid or to the oil used to flush the acid from the tubing; sometimes one agent is used in the acid and another in the oil.

Since emulsion formation may take place with either fresh or spent acid, and the behaviour of different crudes may be very diverse, it is necessary to have a convenient method of determining which is the most suitable agent to add. A test for this purpose has been developed which may be carried out on the field using a portable

kit: To a 4-oz. bottle containing 20 ml. of acid, or acid spent against limestone from the producing horizon, are added the appropriate quantity of demulsifier and 80 ml. of oil, and the bottle is shaken vigorously fifteen or twenty times. By comparison of the rates of breakdown of the emulsion using different agents, the appropriate demulsifier for the crude in question can be selected.

Results of tests using agents of five different chemical types on a number of crudes are given, but the actual compositions of the demulsifiers are not quoted. Finally, reference is made to the necessity for keeping agitation of the spent acid and oil to a minimum, if emulsion troubles are to be entirely avoided. T. T. D.

1135.* Use of Natural Gas in Oil Refineries. F. S. Kelly, Jr. *Oil Gas J.*, 19.6.41, **40** (6), 52.—Refineries are among the biggest consumers of natural gas, and although the introduction of modern plant has resulted in a constant decrease in heat requirements per unit of through-put, the demand for natural gas has increased as still gases—the alternative source of heat—are utilized for polymerization to higher-octane gasolines, etc. The author stresses the advantages, from the economic viewpoint, of still further replacing still gases as fuel by natural gas, to free the valuable olefins found in the former, but not the latter, for use as raw material for synthesis.

A typical still gas with a heating value of 1878 B.T.U. per cu. ft. can be priced at 18·8 cents per 1000 cu. ft. if used as a fuel. In a thermal polymerization plant the value of the products would be 34·6 cents for polymer gasoline and 10·7 cents for residual fuel gas—*i.e.*, for every 1000 cu. ft. of still gas burnt as fuel there is a potential loss of 26·5 cents gross revenue. Extrapolating from this, the author estimates the loss of potential gross revenue through burning still gases as fuel to be $31,500,000 per annum for refineries in the Mid Continent, Gulf Coast, and California areas only.

T. T. D.

1136. Steels and Alloys Developed for High-Temperature Refining. B. B. Morton. *Oil Gas J.*, 26.6.41, **40** (7), 60.—An historical paper, the first half of which deals with the development of tests for the study of metal behaviour at high temperatures. Petroleum refiners found, at an early date, that at elevated temperatures metals behaved somewhat like plastics, in that "creep"—*i.e.*, continuous elongation in the direction of maximum stress—took place. In collaboration with other industries, the "creep," the "rupture," and the "relaxation" tests and their variations were devised. Intensive studies, by means of these tests, led to an accumulation of data, from which the author picks out the salient facts, and part of which he presents in the form of charts and of curves.

In addition to possessing adequate mechanical strength, metals must also be resistant to oxidation and corrosion, and the second half of the paper therefore consists of a brief review of the effects of different alloying elements on the high-temperature properties of steels and of alloys. Chromium confers on steel resistance to oxidation and to sulphur attack, whilst molybdenum improves resistance to creep and to the action of organic acids. Nickel chromium steels are very resistant to sulphur, possess the best load-carrying abilities, and are used for the heat-resisting parts of furnaces. Tungsten and silicon are useful alloying elements, whilst carbon, although having a profound effect on the mechanical properties of steels at low temperatures, does not appear to increase the creep resistance above about 900° F. J. C.

1137.* Compact Unit for Reconditioning Absorption Oil Employs Direct-fired Heater. J. C. Albright. *Petrol. Engr*, Midyear 1941, **12** (10), 74.—In recent years the use of kerosine instead of mineral seal oil as absorption oil has rendered possible the removal by distillation with direct-fired heaters of the tarry residuum, without cracking of the absorption oil. This residuum generally results from carry-over of crude in the field separators, and causes emulsions and the fouling of bubble-plates. A reconditioning unit at a Wilmington refinery consists of a tubular heater, a flash-tower into which the heated oil is sprayed, containing a dephlegmator, condensers, and separators. The absorption oil used is a 360–456° F. cut of A.P.I. gravity 38·2°, and is reconditioned when colour and gum content indicate the necessity. The residual matter from the distillation is used as road-oil on refinery roads. C. L. G.

1138.* Reforming Unit Designed for Illinois Naphtha. J. V. Hightower. *Refiner*, August 1941, **20** (8), 291–293.—The total virgin naphtha fractions from the crude still, together with all the crude still gas, constitute the charge to the reformer. The naphtha fractions run first to intermediate storage and then to the reformer, but the crude still gas is compressed directly into this unit to avoid vapour losses. Average operating data show an over-all liquid recovery of 96·6% of the crude charged. The remainder consists of residual gas which is burned to provide the larger part of the refinery fuel requirements.

Operation of the reformer is relatively simple, requiring one man per shift. It involves the low-pressure, high-temperature reaction characteristic of vapour-phase cracking, with the additional feature of gas recirculation. The unit represents substantial process simplifications over previous designs, particularly in elimination of the compressor formerly used to supply gas to the gas-heating coil. A diagram illustrates the principal features.

The reformer feed consists of three products from the crude still: the still gases, light naphtha (75–220° F.), and heavy naphtha (190–410° F.). The still gases enter the reformer just above the main condensers, and pass through the recovery system. The light naphtha is fed into the stabilizer together with the reformed naphtha, so that the final gasoline from the unit is a stabilized blend of the light virgin naphtha, the reformed naphtha, and whatever recoverable fractions were present in the crude still gases.

The heavy naphtha is charged from tankage into the absorber, countercurrent to the rich gases flowing from the reflux drum of the fractionator tower. The flow of the materials and of heat are detailed.

The furnace is double-end fired, with two combustion chambers separated by a convection section. Burners of the combination oil-gas type are used in conjunction with refractory muffles, six burners being used to heat the vaporizer-superheater coil and six to heat the cycle-gas coil. The furnace has a steel self-supporting stack. The tube-backs are supported on structural steel and are independent of the roof. The tubes in the vaporizer-superheater coil are all 3½-in. O.D., 4–6 chrome, ½ molyb.-steel, with box-type headers cast of the same alloy. In the cycle-gas coil the tubes are all 2½-in. O.D. with box-type headers of 4–6 chrome, ½ molyb.-steel. With the exception of the last twelve tubes in this coil, which are chrome-silicon alloy, the tubes are 4–6 chrome, ½ molyb. The tubes in both coils have ¼-in. walls. The transfer line from the coils to the reactor is 4–6 chrome, ½ molyb. A. H. N.

1139.* Copper Alloys in Refining. W. L. Archer. *Refiner*, August 1941, **20** (8), 301–306.—To explain the corrosion problem as influenced by sulphur and oxygen contained in the oils and waters processed, each element is discussed separately. To predict corrosion results in large-scale refiners, it is stated that laboratory work under accelerated or artificial environments is usually misleading. One of the most promising schemes that has been attempted with success is the installation of pilot plants alongside and paralleling regular equipment in those phases of the process where corrosion data are needed. The small units are operated in exactly the same manner as the production units. Runs are made for definite time periods; the pilot equipment is then opened and examined while production continues unabated. Careful, methodical attention is given to the experimental equipment, and much is learned. Considerable data are gained at moderate expense through this plan, and until more work is completed in the complex subject of corrosion studies, all reports of materials in their relation to attack by small amounts of impurities in relatively inert, and large volumes of either petroleum hydrocarbons or water must, of necessity, be conservative.

Not much pure copper is used for corrosion-resistant installations in the refinery. Rather the copper alloys, many of which contain small additions of other elements, are to be found. The brasses, the bronzes, and copper nickel alloys are the most prevalent types. Because of the many copper alloys available, an attempt must be made at simplification of the whole copper set-up. The brasses are combinations of copper and zinc. The bronzes are generally copper with tin or aluminium or silicon. When the latter two elements are included in the composition to form the bronzes, modifying and descriptive terms are employed as aluminium bronze or silicon bronze. Thus a bronze without a prefix of aluminium or silicon may be assumed to be a regular tin-bearing bronze.

Five groups of copper alloys predominate in refinery service. These are: (1) brass—copper with zinc; (2) bronze—copper with tin; (3) (*a*) cupro-nickel—copper with nickel, (*b*) nickel silver—copper, nickel and zinc; (4) aluminium bronze—copper with aluminium; (5) silicon bronze—copper with silicon.

The above listing has been simplified in the extreme, for the bronzes always contain phosphorus as well as tin; the silicon bronzes always contain about 1% manganese, tin, or zinc. These alloys are then considered in detail in connection with their services in the refinery, their properties, and limitations. Welding copper alloys are finally discussed. A. H. N.

1140.* Economics of Gasoline Plant Design. I. A Mathematical Analysis of Heat Exchanger, Furnace, Cooling Tower, and Fuel Gas Costs. C. Hetherington and R. L. Huntington. *Refiner*, August 1941, **20** (8), 307–309.—Through use of the calculus, the engineer who is designing a gasoline plant can save much time in arriving at the proper relationship of the cost and size of the respective units which make up a complete plant. In this paper such an example is worked out by summing up the several cost items in terms of one variable, followed by a differentiation of this total cost with respect to the particular variable. By this procedure the optimum economic cost can be determined much more quickly than by the more tedious method of plotting up the variables on many graphs. To indicate the scope and nature of the problem the following set of data is reproduced: (1) rich oil 4400 lb./min., specific heat = 0·5, entering at 90° F.; (2) lean oil 4000 lb./min., specific heat = 0·6, entering at 350° F.; (3) gas is worth 8 cents/1000 standard cu. ft. of 1000 B.T.U./standard cu. ft. gas, or 8 cents/million B.T.U.—60% of the heat is absorbed in the furnace; (4) the combined investment in a furnace or boiler plant and cooling tower is \$1000/million B.T.U. capacity/hr. and the fixed charges amount to 20%/yr., assuming 350 days of operation/yr.; (5) heat exchangers of the approximate size required cost \$10/sq. ft. of heating area with a coefficient of heat transfer equal to $\frac{75 \text{ B.T.U.}}{\text{hr.} \times \text{sq. ft.} \times {}^\circ\text{F.}}$. A. H. N.

1141.* Unit Costs for Compressed Air and Steam. J. R. Darnell. *Refiner*, August 1941, **20** (8), 314–316.—Due to errors in calculations in the article "Unit Costs of Compressed Air and Steam," *Refiner and Natural Gasoline Manufacturer*, January 1941, pages 50, 51 and 52, unfavourable comparisons were made to the disadvantages of compressed air power. The article is reproduced as corrected by the author, J. R. Darnell.

In this reproduction the first paragraph of the original manuscript has been omitted, corrections have been made as to cost of producing compressed air power, and a corrected Table I substituted.

The original paper was abstracted in Abstract No. 319. A. H. N.

1142. Patents on Refining and Refinery Plant. F. B. Allen. U.S.P. 2,245,549, 27.6.41. Appl. 17.5.38.—Method of handling hot fluid viscous petroleum coke. The process includes flowing the material through a conduit, discharging it therefrom in a solid stream, and discharging a number of disintegrating jets of water under pressure into the solid stream material, thereby breaking it into small particles. The disintegrated material is collected in a body of water placed below the jets.

T. P. Simpson and J. W. Payne. U.S.P. 2,245,016, 27.6.41. Appl. 25.5.39.—Improved method of refining solvent refined petroleum oils with porous adsorptive materials. The adsorptive material carries an outer layer deposit of activated carbon produced from petroleum carbonaceous matter.

G. W. Nederbragt. U.S.P. 2,246,982, 24.6.41. Appl. 21.1.39.—Separation of hydrocarbon mixtures substantially free from asphalt into fractions of different characters. A fraction of the mixture having a relatively slight paraffinic character is solidified from a solution thereof with a paraffin solvent, and a fraction having a relatively highly paraffinic character is also solidified with a non-paraffinic solvent. The solidified fractions and the unsolidified hydrocarbons from one of the solidification

steps containing fractions of slightly and highly paraffinic character are employed as solute in the other solidification step.

R. E. Burk. U.S.P. 2,247,148, 24.6.41. Appl. 24.12.38.—Treatment of cracked petroleum distillates for colour. The sulphur content is first estimated, and the constituents causing coloured particles reduced by subjecting the distillate to elevated temperature with an amount of iron carbonyl less than that which would correspond to the amount required to react with total sulphur.

W. A. Smith. U.S.P. 2,247,926, 1.7.41. Appl. 9.3.38.—Improvement in the refining of hydrocarbons which lies in reducing the viscosity where necessary, and afterwards subjecting the product at the same time to the action of sulphuric acid and an aryl nitro in which the NO_2 group is attached directly to a benzene ring.

W. E. Forney. U.S.P. 2,248,496, 8.7.41. Appl. 9.7.36.—Oil-stock which is to be refined is passed through a series of contacting zones in one direction and sulphuric acid introduced into the last zone of the series. A gas containing olefin is introduced into the first zone, and the gas reacted with the sulphuric acid to produce a mixture of alkyl sulphates and sulphuric acid. The mixture is then passed counter-current to the oil through the series of zones to extract oil from the non-paraffinic constituents, and the extracted oil discharged from the last zone of the series. The alkyl sulphate extract is discharged from the first zone.

H. H. Gross and W. Smisloff. U.S.P. 2,248,498, 8.7.41. Appl. 24.2.39.—In the process of dewaxing oils by continuous filtration, the steps comprise mixing a dewaxing solvent with the oil, chilling the mixture to precipitate wax, passing the chilled mixture to a filter to remove precipitated wax and segregating a fraction containing comparatively little wax-crystal modifying material. Prior to filtering the wax-oil ratio is increased in order to control character and thickness of the cake and facilitate a higher production rate.

W. P. Geo. U.S.P. 2,248,668, 8.7.41. Appl. 11.2.39.—Dewaxing oils by means of a continuous rotary filter. A dewaxing solvent is mixed with the oil and the mixture on chilling and filtering deposits a thin cake on the filter which it is difficult to discharge. The chilled mixture is then passed to a filter to remove precipitated wax and to produce a dewaxed filtrate. Prior to filtering a predetermined quantity of wax is incorporated in the oil in order materially to increase the ratio of wax to oil. In this way the character and thickness of the filter cake are controlled, and at the same time the cake is rapidly formed and removed from the filter.

W. J. Ryan and N. T. Kendall. U.S.P. 2,249,276, 15.7.41. Appl. 18.9.40.—Process for the treatment of cracked petroleum hydrocarbon distillates of high sulphur content. The distillate is subjected to the action of sulphuric acid of 55–60% strength and the gum forming bodies thus removed without substantially affecting other constituents. Afterwards the oil is treated with caustic alkali solution at a temperature of at least 150° F., while under substantial superatmospheric pressure. In this way sour sulphur compounds are removed and a sweet product remains.

W. J. Ryan and M. T. Kendall. U.S.P. 2,249,277, 15.7.41. Appl. 18.9.40.—Treatment of cracked petroleum hydrocarbon distillates. A highly cracked naphtha distillate is subjected to the action of aqueous caustic alkali at a temperature of at least 150° F., while under substantial superatmospheric pressure. Sulphur compounds are in this way removed from the oil. Then the distillate is treated with sulphuric acid (55–60%) to remove gum-forming bodies without substantially affecting other constituents of the oil.

E. Kolthoff and A. E. Catanach. U.S.P. 2,250,915, 29.7.41. Appl. 29.5.40.—Method of sweetening sour hydrocarbon oils by contacting with a suspension of ferric hydroxide and lead sulphide in caustic alkali solution.

M. S. Arguss and W. H. Sowers. U.S.P. 2,251,773, 5.8.41. Appl. 12.1.39.—Process in the solvent refining of mineral oils. An oil containing paraffinic constituents and naphthenic hydrocarbons is separated into fractions respectively higher in paraffinic and naphthenic compounds by extracting with compounds selected from the group consisting of morpholine and its constituents.

C. M. Blair. U.S.P. 2,252,959, 19.8.41. Appl. 31.5.40.—Treatment of pipe-line oil to reduce the inorganic salt content. Fresh water is mixed with the oil in such a way as to produce an admixture in which a major proportion of the original water droplets co-exist, but are not combined with the droplets of added water. The admixture is heated to breaking temperature and thereafter subjected to gentle agitation to effect coalescence to a larger extent of water droplets. The coalesced water masses will thus remove the greater part of the salt content of the original oil. A chemical demulsifying agent is incorporated prior to agitation. Afterwards the admixture is allowed to settle and the oil and water phases are separated.

W. L. Benedict. U.S.P. 2,253,011, 19.8.41. Appl. 31.12.37.—Method of sweetening hydrocarbon distillates by treating with a slurry produced by suspending cuprous chloride in an aqueous ammonium chloride solution. The distillate is separated from the resultant reaction products and then further treated with cupric salt.

R. Rosen. U.S.P. 2,253,308, 19.8.41. Appl. 5.5.37.—Method of desulphurizing a normally liquid hydrocarbon mixture boiling within the gasoline range and containing organically combined sulphur. A hydrocarbon composition containing at least one carbocyclic hydrocarbon is added to the original material and the resultant mixture passed in contact with a dehydrogenating catalyst. The hydrogen sulphide is removed from the reacted mixture, the reaction being carried out in the absence of added free hydrogen. H. B. M.

Chemistry and Physics of Petroleum.

1143.* Proposed Method of Designating Colour. F. Scofield, D. B. Judd, and R. S. Hunter. *A.S.T.M. Bull.*, 1941, **110**, 19–24.—In this tristimulus method it is proposed to specify the colour of an object by three numbers. These are either the luminous apparent reflectance or the luminous transmission, depending on whether the specimen is viewed by reflected or transmitted light, together with two numbers, α and β, specifying the chromaticity. The numbers α and β are related to the x and y co-ordinates on the I.C.I. system.

It is claimed that the proposed system possesses these definite advantages over the I.C.I. system:—It is superior for colours subtending a large visual angle, owing to the uniformity of chromaticity spacing. The chromaticity diagram is plotted in rectangular co-ordinates with the origin at the neutral point, and the values of α and β can be transformed readily into polar co-ordinates, and, from the latter, numbers may be obtained corresponding to hue, lightness, and saturation. The values of α and β may be determined rapidly with photo-electric tristimulus colorimeter. Equations are given expressing α and β in terms of the readings relative to a standard obtained with the amber, green, and blue filters of the multipurpose reflectometer.

The paper gives a number of applications of the method, such as the indication of the depth of colour permissible in oils, varnishes, etc., the amount of fading of tinted paints, and the degree of yellowing of white paint and enamels.

In the case of the colour of lubricating oils the advantage of the tristimulus method over the A.S.T.M. Union colorimeter is shown diagrammatically. J. F. T.

1144. Wetting Agents. F. E. Bartell. *Chem. and Ind.*, 1941, **60**, 26, 475–479.—The absence of suitable methods for evaluating wetting agents has retarded the development and technical application of these substances. This paper is a study of the methods of evaluation of surface-active agents from the surface-tension and interfacial tension lowering properties of these agents. The three systems—liquid–air, liquid–liquid, liquid–solid—are considered.

In the case of the liquid–air and liquid–liquid systems, the determination of the surface tension and interfacial tension of the liquid + surface-active solute gave erroneous results with the capillary, bubble-pressure, and ring methods, due to the time required to obtain equilibrium conditions. The pendant-drop and sessile-bubble methods were found to be the most suitable.

With solid–liquid systems the change in interfacial tension due to the addition of the surface-active agent is numerically equal to the change in adhesion tension. The

latter is shown mathematically to be a measure of the degree of wetting of a solid by a liquid, and can be determined from the surface tension of liquid to air and the angle of contact of solid to liquid. Six methods are considered for the measurement of contact angles, and, of these, the sessile-drop and bubble methods are suitable for the majority of systems, the pressure of displacement method is the only one possible when the solid is in a finely divided condition, the tilting-plate and vertical-rod methods are practicable in the case of rods, wires, and fibres, whilst the capillary tube method is of limited value. The paper concludes with a discussion on the reproducibility of contact angles. J. F. T.

1145.* Uses of Wetting Agents. S. Lenher. *Chem. and Ind.*, 1941, **60**, 27, 497–500.—This paper is a compilation of the commercial uses of wetting agents in aqueous systems in the following industries: Textile, Leather Manufacturing, Fur, Petroleum, Paper, Metal Processing, Paint, Cleaners and Cleaning, Cosmetic, Ceramic, Rubber, and in Agriculture. J. F. T.

1146.* Homologous Series of Alkanes. G. Calingaert, H. A. Beatty, R. C. Kuder, and G. W. Thomson. *Industr. Engng Chem.*, 1941, **33**, 103.—From a careful review of the literature, the temperature coefficients of the density for normal and branched-chain alkanes have been obtained, by selection, from smoothed data.

The molecular volumes in the liquid state at 20° C. of the normal alkanes from butane to eicosane are shown to be represented by the relation $V = 30{\cdot}392 + 16{\cdot}375N + \frac{74{\cdot}44}{N^2}$ where N = number of carbon atoms.

The molecular volumes in different homologous series of branched-chain alkanes, with the possible exception of the initial members of each series, differ from those of the corresponding normal isomers by a constant quantity, which is characteristic for the series. The use of an alignment chart (nomogram) to detect erroneous or suspicious density values in the literature is illustrated. H. E. T.

1147.* Catalysis Serves the Petroleum Industry. H. S. Taylor. *Industr. Engng Chem.*, 1941, **33**, 582.—A review of the rôle played by catalytic processes in the petroleum industry, and the relation of these processes to present-day demands on the petroleum chemist. H. E. T.

1148.* Furfural as a Solvent. F. Trimble. *Industr. Engng Chem.*, 1941, **33**, 660.—As a selective solvent, furfural has become of considerable industrial importance in two widely divergent fields—namely:—

(1) the treatment of lubricating oils to remove aromatic and sludge forming components;
(2) the refining of crude resin.

In spite of its wide industrial importance as a solvent, data on the solvent properties of furfural are incomplete. The present paper seeks to remedy this defect.

In order that the data obtained might be of value in industrial processes, it was considered advisable to prepare the compound of a purity that might easily be attained commercially, rather than to strive for the utmost purity, and thus obtain data which might not be of any practical value.

The furfural used was obtained by carefully fractionating the commercial product three times in an all glass apparatus under a pressure of 12 mm. It had the following properties:—

Boiling range at 25 mm., °C.	64–65
Specific gravity d_{25}^{25}	1·1584
Refractive index n_D^{20}	1·5255
Moisture, %	0·0
Acidity (calc. as acetic acid), %	0·002–0·003.

The solubilities of (*a*) organic acids, (*b*) inorganic salts, (*c*) various organic compounds, in furfural were determined at 25° C., and the results obtained are given in tables.

Further, the mutual solubilities of furfural and petroleum ether were also determined.

The results of this work indicate that, in general, inorganic salts are almost insoluble in furfural at ordinary temperatures, exceptions being the hydrates of barium hydroxide, calcium nitrate, and ferric chloride. Anhydrous zinc chloride was very soluble. Sulphates were insoluble, but chlorides exhibited a slight solubility. H. E. T.

1149.* Natural Gas Hydrates. W. I. Wilcox, D. B. Carson, and D. L. Katz. *Industr. Engng Chem.*, 1941, **33**, 662.—Natural gases under pressure unite with water to form crystalline hydrates at temperatures considerably above 32° F. This paper reports data obtained on the temperatures, and pressures up to 4000 lb. per square inch, at which three natural gases form crystalline hydrates.

The phase data on hydrates of pure hydrocarbons were enlarged by the equilibrium temperatures and pressures for the hydrate formation from compressed liquid propane.

In addition, the concept was introduced of handling vapour–solid equilibria in the same manner as the vapour–liquid equilibria data have been used to predict the phase relations of fluid hydrocarbon systems. H. E. T.

1150.* Rate of Reaction in the System Mineral Oil–Oxygen. D. J. W. Kreulen and D. Th. J. Ter Horst. *J. Inst. Petrol.*, July 1941, **27** (213), 275–292.—This paper deals with a study of the reaction velocities in the system mineral oil–oxygen. Of the two methods available for the measurement of the rate of reaction in the system liquid–gas, that according to Luther and Plotnikow modified by Reinders and Vles was employed. The average reaction was followed by measurement of the mean dipole moment as a function of time. During the oxidation the specific dispersion remained practically constant, indicating that no cyclization occurred during the experiments. From the figure representing the increase of the average dipole moment plotted as a function of time it is apparent that no appreciable increase of polar compounds can be observed until an induction period, with an initial period of very slow reaction, is passed. Beyond this induction period there exists a linear relation between μ and the time of oxidation.

In the second part of the paper the influence of copper and tin on the rate of reaction and on the length of the period of induction is examined. B. M. H. T.

1151.* Preparation of Methyl Chloride From Natural Gas. Yu G. Mamedaliev, V. V. Dementiera, A. M. Kuliev, and A. A. Bakhshier. *J. Appl. Chem. U.S.S.R.*, 1939, **12**, 1826–1839. Translated by A. A. Boehtlingk. *Foreign Petrol. Tech.*, April 1941, **9** (4), 151–164.—Previous work by these authors dealt with a detailed investigation of the reaction of the chlorination of natural gas up to carbon tetrachloride. In the present work the reaction was directed towards the highest yield of methyl chloride. The method consisted briefly in passing natural gas and chlorine into a Pyrex glass, quartz, or metal tube placed in an electrically heated tubular furnace. The reaction tube was provided inside with a pocket for the thermocouple. The entire volume of the reactor in the heated zone was charged with the catalyst. At a temperature of 350–500° C., 80–85% of the chlorine and methane passed through the reactor were used up exclusively for the formation of methyl chloride. A lowering of the temperature facilitated a sharp decrease of the reaction velocity constant, and 93% of the condensate was composed of chlorine at a temperature of 300° C. At increased temperature, a decomposition of chlorine derivatives of methane took place, which led to a lowering of the yield of methyl chloride and simultaneously to an increase in its concentration in the condensate.

Of the catalysts investigated the best were copper dichloride with pumice stone, copper dichloride with the addition of cerium chloride, iron shavings, and aluminium shavings.

The yield of methyl chloride depends directly on the ratio of the reacting gases. The best yields were obtained at a gas ratio of $CH_4 : Cl_2 = 10 : 1$. At a ratio of $CH_4 : Cl_2 = 2 : 1$, more than 50% of the condensate was composed of higher chlorine derivatives of methane. B. M. H. T.

1152.* Catalytic Hydration of Olefins. Application of Sulphuric Acid as a Catalyst for the Preparation of Trimethyl-carbinol from *iso*Butylene in a Continuous Plant.

E. K. Remiz and A. V. Frost. *J. Appl. Chem. U.S.S.R.*, 1940, **13** (2), 210–214. Translated by A. A. Boehtlingk, *Foreign Petrol. Tech.*, April 1941, **9** (4), 165–172.—In order to define the most favourable conditions for carrying out the hydration of *iso*butylene when using solutions of sulphuric acid as catalysts, the following factors were investigated: concentration of sulphuric acid, reaction temperature, concentration of the admixture of silver sulphate activating the reaction, and the velocity of the gas-feed.

From the data obtained it appears that the reaction of hydration of *iso*butylene to trimethylcarbinol proceeds with the highest yields within the temperature range of 85–93° C., the latter being the most favourable temperature. The best results are obtained when using for the catalyst aqueous solutions of sulphuric acid containing 10–30% by weight of the monohydrate with the addition of 2% silver sulphate. Under corresponding velocities of feeding the *iso*butylene, the yields of trimethylcarbinol can be brought up to 50 gm. per hour in the presence of 1 litre of the catalyst at a conversion amounting to 4% of the amount of gas passed. The concentration of the alcohol which is condensed in the receiver reached 10–12% by weight.

B. M. H. T.

1153. Sulphonation of *iso*Butylene. I.—2-Methylpropene-1 : 3-Disulphonic Acid and Related Compounds. C. M. Suter and J. D. Malkemus. *J. Amer. chem. Soc.*, 1941, **63**, 978–981.—The dioxane salt of 2-methylpropene-1 : 3-disulphonic acid (A) was prepared by passing *iso*butylene into a suspension of dioxane sulphotrioxide in ethylene chloride at 0° C. and precipitated as a granular white hygroscopic solid by allowing to stand for several days or heating to about 60° C. The sulphonic anhydride was prepared by refluxing with thionyl chloride and found to be stable to hydrolysis. The disulphonyl chloride was prepared by heating the dioxane salt, a metal salt, or the sulphonic anhydride with phosphorus pentachloride; it was also synthesized from methallyl chloride. Evidence is put forward for the structure of A.

R. D. S.

1154. Kinetics of Oxidation of Typical Hydrocarbons. R. A. Day, Jnr., and R. N. Pease. *J. Amer. chem. Soc.*, 1941, **63**, 912–915.—Measurements were made of the ignition and cool-flame characteristics of some highly branched paraffins (*n*-heptane, 2 : 2 : 3-trimethylbutane, 2 : 2 : 4-trimethylpentane, and 2 : 2 : 3 : 3-tetramethylbutane), two naphthenes (*cyclo*hexane and *cyclo*propane), benzene, and propane. Rates of slow oxidation were also measured for a number of hydrocarbon–oxygen mixtures. Oxygen was used instead of air, so that cool-flame formation and ignition occurred well below atmospheric pressure and the rates of oxidation could be measured conveniently by pressure change. Both series of measurements put the hydrocarbons in the same order as that of the critical compression ratios in internal-combustion engines. Benzene and *cyclo*propane gave no cool flames. Comparison between *n*-heptane and 2 : 2 : 4-trimethylpentane (*iso*-octane) made at 225° C. showed the former to react 3 to 8 times as fast as *iso*-octane. Other data also conformed with the superiority of *iso*-octane as an anti-knock fuel. 2 : 2 : 3 : 3-tetramethylbutane, which has no secondary or tertiary carbon atoms, behaved similarly to its isomer, *iso*-octane, which has both. The extent of the branching appears to be the important factor rather than the group exposed.

R. D. S.

1155. Densities and Refractive Indices of Unsaturated Hydrocarbons. M. L. Huggins. *J. Amer. chem. Soc.*, 1941, **63**, 916–920.—This paper is an extension of the author's previous work on the liquid paraffins (*J. Amer. chem. Soc.*, 1941, **63**, 116–120; *J. Inst. Petrol.*, 1941, **27**, Abstr. No. 950), and is based on data collected by other authors. It shows that the former simple additivity relations for molal volume and molal refraction are not accurate within experimental error, and that certain modifications to these equations give greater accuracy. The constants in the refraction equations deduced agree with the assumption that each bond (according to the atoms linked by the bond and the number and nature of other atoms attached to the atoms joined by the bond) contribute characteristic amounts to the total molal refraction. If two double bonds are adjacent or conjugated, the effect of other atoms is specially important. Owing to the more complex nature of unsaturated compounds, the agree-

ments between calculated and observed values was not so good as in the case of the paraffins. R. D. S.

1156. Catalytic Dehydration and Dehydrogenation of Butyl and Amyl Alcohols. V. I. Komarewsky and J. T. Stringer. *J. Amer. chem. Soc.*, 1941, **63**, 921–922.—The dehydration and dehydrogenation of aliphatic C_4 and C_5 alcohols to diolefins under the catalytic effect of chromia–alumina catalysts are described. The alumina acted as dehydrator and the chromia as dehydrogenator. Alumina alone produced a pure dehydration of alcohol to olefin. R. D. S.

1157. Ultra-Violet Absorption Spectrum of 1 : 3-*cyclo*Pentadiene. L. W. Pickett, E. Paddock, and E. Sackter. *J. Amer. chem. Soc.*, 1941, **63**, 1073–1077.—The ultra-violet absorption spectrum of 1 : 3-*cyclo*pentadiene vapour was measured between 32,000 and 66,000 cm.$^{-1}$ It consists of an intense band with maximum about 43,000 cm.$^{-1}$ on which is superimposed a number of narrow bands, and a prominent group of narrow, discrete bands between 50,000 and 54,000 cm.$^{-1}$ There appear to be two band systems, both of which involve four prominent vibration frequencies which seem to be totally symmetrical vibrations. The absorption spectra of solutions of *cyclo*- and di*cyclo*-pentodiene in optically pure hexane were also measured. R. D. S.

1158.* Molal Volume Relationships among Aliphatic Hydrocarbons at their Boiling Points. G. Egloff and R. C. Kuder. *Phys. Chem. J.*, 1941, **45** (5), 836; *J. Inst. Petrol.*, July 1941, **27** (213), 260–274.—The molal volumes at their boiling points of sixty-three aliphatic hydrocarbons comprising fourteen different homologous series have been correlated with a number of carbon atoms in the molecule by means of equations of the type

$$V = a(n + 4{\cdot}4)^c + K$$

in which a, c, and K are constants, and n is the number of carbon atoms in the molecule. The standard deviation of the calculated from the observed values is 0·48 ml.-mol. (0·30%). The boiling-point molal volume of forty-three aliphatic hydrocarbons comprising nine homologous series have been correlated with the boiling point. A standard deviation of 0·79 ml.-mol. has been obtained by means of equations of the type

$$\text{Log } (V - K) = At + B$$

where K, A, and B are constant, and t is the boiling point in °C. The effect of the molecular structure on the boiling-point molal volume is discussed. J. W. H.

1159. Fluorescence of Hydrocarbons and of their Mixtures with Naphthacene. F. Weigert. *Trans. Faraday Soc.*, 1940, **36**, 1033–1035.—In the study of the biological properties—*e.g.*, carcinogenicity of hydrocarbon—an attempt was made to utilize the green and blue fluorescence of the studied hydrocarbon as an easy colour test to decide whether the hydrocarbon was present in crystals or in a molecularly dissolved state. T. C. G. T.

1160. Emulsions—Part I. Mechanism of Emulsification of a Standard Emulsion in Sodium Oleate Solution. A. R. Martin and R. N. Hermann. *Trans. Farad. Soc.*, 1941, **37**, 25–29.—Using pure carbon-dioxide-free N/30 sodium oleate solution, the authors have prepared emulsions (60% by vol. of oil) of paraffin, benzene, *n*-nonyl alcohol, etc., by the method of intermittent hand-shaking and subsequent homogenization in a cream-mixer. It was found that liquids giving unstable W/O emulsions could be made to give O/W emulsions by increasing the rest period between shakes, and the mechanism by which this occurs is discussed. Liquids with an interfacial tension greater than 42 dynes per cm. can give O/W emulsions by the modified procedure, but those with a lower value (including the higher paraffins) give O/W emulsions by the standard procedure. It is pointed out that in order to understand the process of emulsification it is necessary to distinguish between the reduction of the liquid to droplets and the subsequent stabilization of these droplets by the emulsifying agent. By determining the average diameter of the droplets, the percentage of sodium and oleic acid at the interface, and the percentage area per molecule adsorbed, it was

shown that the interfacial film is monomolecular. In standard paraffin and benzene emulsions the film consists of acid-soap, whilst in nonyl alcohol emulsions there appears to be a composite film of sodium oleate and alcohol. Emulsions of undecyl alcohol were found to exhibit unusual viscosity phenomena, being extremely viscous. This was attributed to the fact that the m. p. of the alcohol was 12° C. and the probability that the composite film of oleate and alcohol may be solid. H. G. W.

1161. Emulsions—Part II. Partial Coagulation of a Standard Emulsion by Salts. A. R. Martin and R. N. Hermann. *Trans. Faraday Soc.*, 1941, **37**, 30–38.—Experiments on the partial coagulation of a standard emulsion of xylene and other oils in sodium oleate solution by "Analar" salts of bi- and higher-valent metals in N/10 solution are reported. In these cases the quantity of salt added was insufficient to react with all the soap present. In the discussion it was shown that the differing amounts of oil separated on partial coagulation must vary with the nature of the added salt, and consequently the reactions between these salts and sodium oleate were studied. With a copper salt, for example, it was found that a basic copper oleate was precipitated by reaction with the alkaline sodium oleate in the aqueous phase. Copper oleate was also formed at the interface, and this, together with some from the aqueous phase, goes into colloidal solution in the oil, peptized by the oleic acid present at the interface, leaving some basic copper oleate in the water. The amount of oil thrown out depends on the amount of oleic acid withdrawn for peptizing the metal oleate, and is large for aluminium salts (high coagulating power) and small for zinc (low coagulating power). Dilution appears to have little effect on this phenomenon. The more highly dissociated nitrates and chlorides are more effective than the sulphate. Emulsions of the higher aliphatic alcohols are very sensitive to salts, since there is little reserve of soap in solution to maintain the interfacial film. H. G. W.

1162. Photolysis of Mercaptans. N. P. Sherrett and N. W. Thompson. *Trans. Faraday Soc.*, 1941, **37**, 81–82.—Lower alkyl mercaptans are photolysed predominantly by the primary process R–SH $\rightarrow$ RS + H, and not by the process RSH $\rightarrow$ RH + S. T. C. G. T.

1163. Some Factors Covering the Stability of Oil-in-Water Emulsions. A. King. *Trans. Faraday Soc.*, 1941, **37**, 168–180.—The stability can only be effectively measured by the rate of coalescence of the disperse phase. There are three fundamentally different classes of emulsions: (1) oil hydrosols (unstabilized), (2) those stabilized by electrolytes, and (3) those stabilized by materials in the ordinary sense, which may be (*a*) colloidal materials or (*b*) finely divided solids. Emulsion stability is not, in general, a function of the degree of dispersion—*e.g.*, coarse emulsions made with gelatinous alumina are very stable (2 years or more). Low interfacial or surface tensions are not important factors in stability, but only the adsorption which accompanies them. If no chemical action occurs between electrolyte and emulsifying agent, the electrical charge on the dispersed droplets does not determine stability or type. High viscosity can only be regarded as a symptom, and not a cause of stability in emulsion systems. Densities and chemical properties of the two phases affect ease of emulsification and stability. It appears that the more extended is the layer of agent at the interface, the more sensitive it is to the influence of electrolytes. The effect of temperature is specific for the different types of emulsions, and cannot be used as an accelerated method of stability comparison. It is also well known that different mechanical methods of preparation lead to great differences in dispersion and stability—*e.g.*, homogenization compared with hand-shaking for soap emulsions gives ten times the specific area of interface and 1·8 times the stability. With solid-stabilized emulsions a gelatinous structure and a basic nature increase stabilization, and aged inert aluminium hydroxide is considered the best. It has been found that sodium oleate increases the power of carbon black to give more stable W/O emulsions. It is concluded that the strength and compactness of the interfacial film are really the most important factors favouring stability. H. G. W.

1164. Stabilisation of Water-in-Oil Emulsions by Oil-soluble Soaps. R. C. Pink. *Trans. Faraday Soc.*, 1941, **37**, 180–184.—The author has examined the effect of water

on benzene solutions of a number of polyvalent metal soaps, and has found that oil-soluble soaps, which are precipitated from solution when shaken with water, give stable W/O emulsions if the precipitated soap (1) is practically insoluble in both phases in the presence of water, (2) remains at the interface and is partly wetted by both liquids, and (3) if there is sufficient lateral adhesion between the solid particles. Mg and Ni oleates and Mg stearate give stable emulsions but not the oleates of Ca, Ba, Sr, Ni or Zn. Another factor of importance in stabilization is that the reduced interfacial tension brought about by the soap permits easy subdivision of the water in the oil, and thus, by bringing the phases into intimate contact, assists in the precipitation of the stabilizing film. Where the metal soaps are insoluble in oil W/O emulsions can be obtained indirectly by inversion of the O/W type. H. G. W.

Analysis and Testing.

1165.* Determination of the Thermo-Viscosity of Light Distillates. L. R. Brown. *A.S.T.M. Bull.*, 1940, **107**, 23–24.—It is suggested that the kinematic viscometer described in A.S.T.M. be adopted for determination of the viscosity of gasoline and kerosine in place of the Saybolt thermoviscosimeter, and it is shown that satisfactory correlation exists between the viscosity in centistokes at 100° F. and Saybolt thermo-viscosity at 60° F. for a variety of kerosines and similar distillates having thermo-viscosities up to 550.

The thermo-viscosity can be derived from the viscosity in centistokes from the relationship :—

Thermo-viscosity at 60° F. = 262 (centistokes at 100° F.) − 39.

A. O.

1166. Method for Determining the Components of Asphalts and Crude Oils. O. G. Strieter. *Bur. Stand. J. Res. Wash.*, 1941, **26** (5), 415.—The author points out that the usual procedure for determining the percentage of asphaltenes, resins, and oily constituents in asphaltic bitumen is not satisfactory owing to the variable results which may be obtained by the use of petroleum naphtha. It is proposed to use pentane instead of naphtha, and ethyl ether instead of carbon disulphide.

Details are given of the method of procedure, which consists of precipitating the asphaltenes with pentane, extracting, in a Soxhlet, a mixture of fuller's earth and the residue from evaporation of the pentane solution, and finally extracting with ethyl ether.

The method can be employed with crude oils as well as asphaltic bitumen. A. O.

1167. Determination of Freezing Points and Amounts of Impurity in Hydrocarbons from Freezing and Melting Curves. B. J. Mair, A. R. Glasgow, Jr., and F. D. Rossini. *Bur. Stand. J. Res. Wash.*, 1941, **26** (6), 591–620.—In the work of the A.P.I. on the isolation and identification of hydrocarbons from petroleum the freezing point of the "best" lot of each hydrocarbon has usually been determined by means of time–temperature freezing or melting curves, and the purity has been estimated from the time–temperature freezing curves by a method published in 1920. The work described in this paper was carried out to check the reliability and interpretation of such measurements.

The apparatus used for obtaining time–temperature freezing and melting curves is described and the method discussed. The curves obtained are analysed, and a procedure is outlined for determining from them the freezing point of a given substance and the amount of impurity it contains. The procedure was applied to a number of different known solutions of hydrocarbons ranging from 0·006–0·115 mole fraction in concentration of solute. The substances used as the main components were 2 : 2 : 4-trimethylpentane, *n*-dodecane, and toluene, whilst the solutes included *n*-heptane, methyl*cyclo*hexane, 1 : 2 : 4-trimethyl*cyclo*hexane, and *m*-xylene.

For the systems examined, the values for the freezing point of a given substance obtained from both freezing and melting curves were always in accord within their respective limits of uncertainty. The estimated amount of impurity was, on the average, in error by not more than about 10% of itself. D. L. S.

1168.* Rotating Disc Viscometer. P. S. Rigden. *J. Soc. chem. Ind.*, 1941, **60** (1), 18–20.—The viscometer has been designed for the rapid determination of the viscosity of tars during the process of fluxing back harder materials with oils, and for investigating the effect of the addition of filler on the viscosity of a binder within the viscosity range of $10–10^{-4}$ poises. The instrument consists of a spindle carrying a disc which is immersed in the material in a container of fixed dimensions and is rotated by weights suspended over pulleys. The disc and spindle may be detached from the main shaft, thereby making for rapidity in use and facilitating cleaning.

Calibration curves showing the variation of viscosity with different weights and with varying depth of material in the container are given. J. F. T.

1169.* New Test Apparatus Enables Navy to Set Service Standards for Grease. R. C. Adams and H. E. Patten. *Nat. Petrol. News*, 9.7.41, **33** (28), R. 218.—Special test apparatus devised at the Engineering Experimental Station of the U.S. Navy Department is described. In the high-temperature service test a standard ball-bearing is packed in a controlled manner, weighed, and inserted in a device for rotating it at controlled speed and temperature and measuring the torque developed. The torque-time curve obtained in 1 hr. is said to be characteristic. The bearing is re-weighed at the conclusion of the test to estimate leakage. The low-temperature service characteristics of the grease are examined by cooling a packed bearing and determining the time required for one revolution under the influence of a predetermined applied torque. The stability test consists of carrying out the above tests before and after beating the grease at 400° F. for 7 hr. in a standard apparatus. A method for the quantitative estimation of dirt is described. H. G.

1170. Construction of Glass Bellows for Fractionating Columns. D. J. Pompeo and E. Meyer. *Rev. Sci. Inst.*, 1941, **12** (7), 368.—In the construction of vacuum-jacketed distillation columns it is necessary to provide some means of taking up the differential expansion between the inner and outer tubes of the column. This expansion is conveniently allowed for by the provision of flexible glass bellows, the design and construction of which are described. J. W. H.

Motor Fuels.

1171. Co-operative Fuel Research Motor-Gasoline Survey, Winter 1940–41. E. C. Lane. *United States Bur. Mines, Report of Investigations*, No. 3576, June 1941.—This report is the eleventh of a series made in accordance with an agreement between the Co-operative Fuel Research Committee and the Bureau of Mines. It presents analytical data on 2020 samples, representing the products of approximately 120 companies.

For purposes of classification, samples are again divided into regular-price, premium-price, and third-grade gasolines, and each group is averaged separately.

Of tables comprising the report, No. 1 gives data on gravity, sulphur content, Reid vapour pressure, octane number, and distillation characteristics. Averages of Table 1 are assembled in Tables 2, 3, and 4. Table 5 gives minimum, maximum, and average figures for each characteristic of each group of gasoline, and Table 6 gives the same figure for the previous winter survey.

Comparison of these tables with those issued for the winter of 1939–40 indicates that the average octane number for both regular- and premium-price gasolines was 1·7 units higher in 1940–41, and for third-grade gasoline 1·4 units higher. The average vapour pressure for the regular- and premium-price gasolines is 0·4 lb. higher, and for third-grade gasoline 0·2 lb. higher than for the winter of 1939–40. Average temperatures in distillations for each grade of gasoline are slightly lower than corresponding values in the previous survey, except in the case of initial boiling point.

Survey of average anti-knock and volatility qualities during the 5-year period 1935–36 to 1940–41 indicates that the average octane number of regular-price gasoline has risen from 69·6 to 74·4, for premium-price grade from 76·7 to 80·2, and for third-grade gasoline from 57·5 to 65·6, the present third-grade gasoline being now only 4 octane numbers below that of regular-price gasoline in 1935–36. Change in volatility

over the same period is shown by increase in vapour pressure, and decrease in the temperatures of the 10, 50 and 90% recovered points of the average winter gasolines.
H. B. M.

1172.* A.S.T.M. Standard Aviation Gasoline Specifications. Anon. *Nat. Petrol. News*, 9.7.41, **33** (28), R. 214.—The complete specifications for Grades 75, 91, and 100 (octane number) aviation gasoline are given, together with detailed methods of testing. The tests comprise: Knock value, lead content, net calorific value, distillation, acidity of distillation residue, vapour pressure, corrosion (copper strip and copper dish), gum (accelerated ageing test with oxygen) sulphur, freezing point and water tolerance.
H. G.

1173.* Notes on an Extended Test of Creosote Mixture in C.I. Engines. W. Allen. *J. Instn. auto. Engrs*, March 1941, **9** (6), 73–82.—Prior to the war, Rochdale Corporation Transport Dept. made tests of creosote/gas-oil mixtures in one bus with a direct-injection diesel engine. Vertical retort tar was found preferable to horizontal retort or coke-oven tar, both of which had a high naphthalene content. When petroleum base oil is mixed with creosote, tar acids dissolve asphalt from the former and produce a gummy precipitate, particularly at the lower atmospheric temperatures. Tests showed that below 30% creosote there were appreciable deposits, reaching a maximum at 15%. Between 30% and 50%, deposits were not appreciable, even at 22° F. On the other hand, mixtures containing over 30% creosote may lead to starting difficulties in cold weather, due to reduced ignition quality.

Following the outbreak of war the entire bus fleet was put on a creosote/gas-oil mixture. The procedure used for blending, settling and centrifuging is described. During exceptionally cold weather some trouble was experienced with autovac failure and sticking of fuel-injection pump elements. Temporary relief was effected by heating the fuel system, but it was concluded that, for winter use, the creosote should be washed to remove tar acids. This reduces the volume of oil available by about 25%. The unwashed creosote also gave rise to some corrosion of filter gauzes and fuel pump delivery valve springs.

Washed creosote (neutral oil) has been in use since March 1940, and the majority of the original troubles have been overcome. When the engines are first started up, the exhaust fumes are in the form of a dense white vapour, which gradually clears. This may be troublesome in a badly ventilated garage. It is concluded that there are distinct possibilities in the use of creosote/gas-oil mixtures during the present fuel shortage, and troubles have been fewer than with the use of creosote in gasoline engines.
K. A.

1174.* British Methane—An Alternative Fuel. Anon. *Petroleum*, 1941, **4** (3), 64.—The potential sources of methane in the United Kingdom are: (1) gas escaping from coal in collieries, (2) bacterial treatment of sewage, (3) combustion of coal in coke-ovens and gas-works, and (4) natural gas—so small in this country as to be negligible.

The purity of gases from various collieries would be 80–90% methane, and there are some mines pouring 500,000 cu. ft. of the gas per day unused into the atmosphere.

Sludge gas produced from sewage is about 70% methane and 30% CO_2, and at present is used in this form by some sewage works for the generation of their own power and electricity.

Coke-oven gas contains about 30% methane and is at present largely wasted.

Methane has a very high octane number and can be used at a compression ratio of 17–20. It can be used in gas-bags on the roof of cars in a similar manner to town gas, or can be compressed into cylinders at 3000 lb. pressure. The normal-size cylinder of gas is equivalent to 2½ gal. of gasoline. If methane could be transported as a liquid, wide possibilities would be open for this fuel.

It is suggested that methane could be utilized for locomotives, as in Italy, and numbers of other possibilities are suggested, particularly for the gas in liquid form.
D. L. S.

1175. Patents on Motor Fuels. W. J. Ryan and M. T. Kendall. U.S.P. 2,246,760, 24.6.41. Appl. 22.3.39.—Preparation of a stable fuel oil having a Saybolt furol viscosity of over 25 sec. at 122° F. The fuel has incorporated a heavy viscous oil residue produced in cracking a hydrocarbon selected from the group of hydrocarbons consisting of paraffin and mixed-base hydrocarbons, and containing colloidal carbonaceous material which precipitates therefrom in storage and on moderate heating. The oil residue is blended with 20–40% by volume of naphthene-base petroleum hydrocarbons of approximately the same viscosity, and in sufficient amount to inhibit substantial precipitation of the carbonaceous material.

U. B. Bray. U.S.P. 2,247,476, 1.7.41. Appl. 8.1.37.—Preparation of a motor fuel containing a small quantity of high-boiling oxygenated gum solvent of the di-butylphthalate type, together with a small quantity of a solvent extract from petroleum, adapted to minimize formation of gummy and resinous products and prevent sticking of valves and rings.

E. R. Kanhofer. U.S.P. 2,248,357, 8.7.41. Appl. 31.7.39.—Production of motor fuel of high octane rating and low olefin content by fractionally distilling crude petroleum, and separating therefrom a light straight-run fraction containing gasoline components of low anti-knock value and a heavier predominantly saturated fraction. The light fraction is then reformed and the products supplied to a catalytic conversion zone containing a cracking catalyst. The gasoline products are subjected to the action of the catalyst at a temperature between 500° and 800° F., in admixture with a quantity of the heavier fraction, and for a sufficient length of time to saturate the major portion of the olefin content of the gasoline products. The resultant vaporous conversion products are fractionated and condensed.

G. Armistead. U.S.P. 2,248,842, 8.7.41. Appl. 23.10.37.—Treatment of hydrocarbons to produce motor fuel of high anti-knock value. A crude oil is fractionated to separate from it a naphtha distillate, a virgin gas-oil and hydrocarbon oil of higher boiling than the virgin gas-oil. The virgin gas-oil is then subjected to cracking conditions to effect substantial conversion to lower-boiling products. These conversion products are then again fractionated to produce a motor-fuel condensate, a gas-oil condensate, and normally gaseous hydrocarbons. The gas-oil condensate is then separately subjected to cracking conditions and converted into lighter products, including motor-fuel constituents. Higher-boiling hydrocarbon oil is merged with the hot products of this cracking operation; the products of this merging operation are subjected to cracking conditions to effect conversion to motor-fuel constituents, and finally a motor-fuel product is recovered from fractionation.

I. H. Kinneberg. U.S.P. 2,249,613, 15.7.41. Appl. 31.10.38.—Conversion of hydrocarbon oils into substantial yields of motor fuel of high anti-knock value. The oil is subjected at a temperature above 500° F. to contact with a catalyst produced by precipitating a hydrous silica, washing, and treating to remove alkali metal ions, depositing metallic aluminium thereon, drying, forming into granules, and calcining.

R. B. Marschner. U.S.P. 2,252,928, 19.8.41. Appl. 10.8.39.—Production of high anti-knock fuel from a low anti-knock fuel containing a substantial amount of naphthenic hydrocarbons. At least a portion of the naphthenic hydrocarbons are nitrated in the low anti-knock fuel, and the product of nitration subjected to catalytic dehydrogenation to reduce the naphthenic hydrocarbons to aromatic amines in an amount sufficient to increase substantially the anti-knock value of the fuel.

A. Belchetz. U.S.P. 2,253,486, 19.8.41. Appl. 20.5.39.—Catalytic conversion of high-boiling hydrocarbons into low-boiling hydrocarbons within the gasoline boiling range. A stream of the high-boiling hydrocarbons having a solid incombustible catalyst suspended therein is passed through a zone for a sufficient time and at the desired temperature to effect conversion to low-boiling hydrocarbons, and also to leave a low-carbonaceous deposit on the catalyst. The used catalyst is separated from the conversion products, suspended in an oxygen-containing gas, and the suspension passed through a regeneration zone to burn off carbonaceous material deposited on the catalyst. The improvement lies in introducing the used catalyst into the regeneration zone, thus enabling it to be used again. H. B. M.

Gas, Diesel and Fuel Oils.

1176.* Fuel and Oil for Motor Transport. T. A. Boyd. *Industr. Engng Chem.*, 1941, **33**, 324.—A review of the present-day situation with respect to the production and supply of gasoline and diesel oil for motor transport. H. E. T.

1177. Patents on Gas, Diesel and Fuel Oils. K. D. Uitti. U.S.P. 2,246,643, 24.6.41. Appl. 30.9.39.—Gases and gasolines produced in hydrocarbon oil conversion are de-ethanized while scrubbing the former with absorber oil to absorb C_3 and C_4 components of the gases. The resultant gas-containing liquid is then stripped to remove normally gaseous hydrocarbons, and a substantially gas-free liquid thus formed. A portion of the gas-free liquid is supplied to the de-ethanizing step as absorber oil, and at least a portion of the hydrocarbons subjected to polymerization. Residual paraffin gases from polymerization are dehydrogenated and the gaseous products thereof scrubbed with more gas-free liquid. The liquid thus enriched is supplied to the stripping step.

V. Vorhees. U.S.P. 2,247,535, 1.7.41. Appl. 16.6.37.—In the conversion of heavy hydrocarbon oils into gasoline, the activity of the catalyst is progressively diminished by decomposition of the carbonaceous material. To counteract this the hydrocarbon oil is initially subjected to separation into a soluble and an insoluble fraction, and the soluble fraction subjected to the action of the catalyst. The resulting products are then fractionated into gasoline and a heavier-than-gasoline fraction, and the insoluble fraction subjected to pyrolytic cracking substantially without catalysts. Products of pyrolytic cracking are fractionated into gasoline and a heavier-than-gasoline fraction, and both fractions recycled directly to the pyrolytic cracking operation for further conversion into gasoline.

E. M. Nygaard. U.S.P. 2,251,156, 29.7.41. Appl. 23.10.40.—Preparation of an improved diesel fuel having admixed therewith a small proportion of an aromatic diazo-thioether. Incorporation of the thioether decreases the ignition delay period of the fuel.

E. M. Nygaard. U.S.P. 2,251,157, 29.7.41. Appl. 23.10.40.—Preparation of a diesel fuel having admixed therewith a small proportion of an aromatic diazo-alkyl ether in sufficient amount to improve the ignition quality of the fuel. H. B. M.

Lubricants and Lubrication.

1178.* Oil-retaining Bronze Bearings. Anon. *Engineering*, 1941, **152** (3944), 128.—Tin-bronze bearings produced by the compression of powdered alloys into dies possess the valuable feature of comprising about 30% by volume, fine pores or capillary spaces. They are impregnated with oil by immersion before despatch, and thus can be made to absorb sufficient oil to maintain the working surfaces in a permanently lubricated condition throughout the working life. It is, however, recommended that before a bearing is actually fitted, it should be dipped into a suitable lubricating oil to ensure an oil film exists at the outset between the bearing and shaft.

Porous bearings have a particularly useful application in cases where oiling is difficult or is likely to be neglected. Several convincing examples of their reliability in practice are given. E. F. C.

1179.* Separation and Composition of a Lubricating Oil Distillate. M. R. Fenske and R. E. Hersch. *Industr. Engng Chem.*, 1941, **33**, 331.—An extensive study has been carried out on an 8% fraction from Pennsylvanian crude oil. The distillate was obtained by commercial distillation from the crude and then dewaxed to a 20° F. pour point and given a light clay treatment to about a 3½ A.S.T.M. colour.

The treated lubricating oil fraction was then subjected to a systematic separation procedure, in which the oil was first extracted by means of 98–99% acetone to yield portions of successively decreasing solubility, and then the fractions so obtained were distilled in a vacuum fractionating unit. The portions thus obtained, comprising 0·6–1·4% of the original oil, allowed the construction of three dimensional diagrams incorporating yield, viscosity index, and molecular weight or viscosity. These diagrams permit an estimation of the distribution of oil fractions with respect to molecular size and molecular type. Further, such three-dimensional diagrams when

employed in conjunction with graphs of boiling-point and aniline-point isotherms superimposed on the composition diagram, suggest methods for the segregation of any fraction of the oil.

Comparison of the physical properties of the fractions with those of synthetic hydrocarbons indicates that the oil fractions, while probably not pure compounds, are segregated into groups varying from monocyclic naphthenes (C_nH_{2n}) to polycyclic aromatics (C_nH_{2n-18}). H. E. T.

1180.* Oxidation of Petroleum Lubricants. L. L. Davis, B. H. Lincoln, G. D. Byrkit, and W. A. Jones. *Industr. Engng Chem.*, 1941, **33**, 339.—The oxidation of petroleum lubricants is an autocatalytic reaction, the initial phases of which have been investigated by an oxygen absorption test. By means of this absorption test the effects of crude source, degree of refining, accelerators, and inhibitors may be studied. Two types of inhibitors are distinguished—true anti-oxidants and precipitants, the latter being only effective against metallic accelerators.

Oxidation products are proximately separable by solvents and adsorption methods. Further, ultimate analyses of insolubles and oil-soluble resins, obtained by stepwise separation from used oil, show decreasing oxygen contents.

The final choice of inhibitors must be determined by practical engine tests. Such tests emphasize the advantages of certain sulphur-bearing derivatives (sulphur-bearing esters of the " Methyl-S-linoleate type and sulphurized olefines derived from petroleum wax) over simple anti-oxidants. H. E. T.

1181. Physical Aspects of Boundary Lubrication. O. Beeck. *J. appl. Phys.*, 1941, **12** (7), 512.—This article is a review of boundary lubrication research. Data are given on the fraction of the macroscopic area which is actually in contact between the sliding surfaces, the surface temperature of sliding metals, friction measurements under boundary conditions, and the effect of surface finish on boundary lubrication. J. W. H.

1182. Frictional Phenomena, I. A. Gemant. *J. appl. Phys.*, 1941, **12** (7), 530.—This is one of a series of articles which will be published to form a monograph of viscous and related frictional forces. In Part I the fundamental mathematical friction equations are discussed and their application to flow between parallel walls is considered. J. W. H.

1183.* Heavy-Duty Motor Oils. H. C. Mougey. *Nat. Petrol. News*, 20.11.40, **32** (47), 34–42.—In tracing the past and indicating the probable future trends in the development of both gasoline and diesel engine, the increasingly exacting demands made on lubricants are stressed. The definition of the term " heavy-duty " is the subject of discussion, but satisfactory lubricating oils must resist oxidation and chemical decomposition in the crankcase, be non-corrosive, and such decomposition products as are formed should cause no significant fouling of engine parts. A plea is made for the co-ordination of the development of fuel, lubricants, and engines. H. G.

1184. Patents on Lubricants and Lubrication. B. H. Lincoln and A. Henriksen. U.S.P. 2,244,886, 27.6.41. Appl. 28.8.39.—Preparation of a lubricant consisting of a major proportion of mineral oil and a minor proportion of a sulphur–chloride treated condensation product of a halogenated paraffin and an aromatic hydrocarbon.

A. J. Morway. U.S.P. 2,245,702, 17.6.41. Appl. 24.11.37.—Preparation of a grease composition consisting of mineral oil and 10–40% of a soda-soap and barium-soap mixture, the soaps being in a proportion of about 10 to 1, to about 1 to 1. The lubricant is substantially anhydrous.

A. F. Caprio. U.S.P. 2,245,649, 17.6.41. Appl. 2.10.34.—Preparation of a steam-turbine lubricant consisting of 50 parts of chlorinated diphenyl and 50 parts of a triarylphosphate.

N. J. Gothard and G. Entwhistle, Jnr. U.S.P. 2,245,772, 17.6.41.—Appl. 21.9.39. —A lubricating grease is prepared by thickening a mineral-oil component with a

soap. The major portion of the mineral-oil component consists of extract obtained by the sulphuric acid–nitrobenzene treatment of a Pennsylvania type oil.

R. A. Potter. U.S.P. 2,246,415, 17.6.41. Appl. 10.4.39.—Preparation of a lubricant consisting of a mineral lubricating oil, from 0·5 to 45% of resin materials, and sulphur in solution in the lubricant in the order of 40% based on the resin content.

G. Kaufman and R. S. Barnet. U.S.P. 2,246,467, 17.6.41. Appl. 14.3.39.—Preparation of a substantially completely dehydrated lime-soap lubricant free from glycerine. The lubricant consists of a mineral lubricating oil, 10–30% of calcium fatty-acid soap and 0·5–3·0% of substantially neutral lanolin as a stabilizer. Equally a dehydrated lime-soap grease can be prepared from a naphthene-base mineral lubricating oil, lime-soap of higher saturated fatty acids, and 0·1–0·7% of glyceryl monostearate as a stabilizer. The lubricant is stable against oil separation and does not break down when heated to temperatures at or above its melting point.

E. J. Barth. U.S.P. 2,246,712, 24.6.41. Appl. 29.4.38.—Preparation of a lubricating oil consisting of petroleum lubricating oil to which has been added an effective amount of dilauryl phenol disulphide.

H. G. Berger, D. E. Badertscher, and F. M. Seger. U.S.P. 2,247,042, 24.6.41. Appl. 25.9.40.—An extreme-pressure lubricant is prepared by admixing with a hydrocarbon lubricating oil a small proportion of the product obtained by the reaction of perchloromethyl mercaptan with an organic amine.

H. G. Berger, D. E. Badertscher, and F. M. Seger. U.S.P. 2,247,043, 24.6.41. Appl. 25.9.40.—Preparation of an extreme-pressure lubricant by admixing a small proportion of the product obtained by the reaction of perchloromethylmercaptan and an aromatic hydrocarbon with a hydrocarbon lubricating oil.

H. G. Berger, D. E. Badertscher, and F. M. Seger. U.S.P. 2,247,044, 24.6.41. Appl. 25.9.40.—Preparation of an extreme-pressure lubricant consisting of a hydrocarbon lubricating oil to which has been added a small proportion of the product obtained by reacting perchloromethylmercaptan with an organic compound having the general formula *ROX*. *R* is selected from the group consisting of alkyl, aryl, alkaryl, and aralkyl radicals, and *X* from the group consisting of hydrogen and the hydrogen equivalent of a metal.

H. G. Berger, D. E. Badertscher, and F. M. Seger. U.S.P. 2,247,045, 24.6.41. Appl. 23.10.40.—Preparation of an extreme-pressure lubricant consisting of a hydrocarbon oil and a small amount of the product obtained by the reaction of perchloromethylmercaptan with a compound selected from the group consisting of organic compounds containing reactive hydrogen atoms and organic compounds containing reactive metallic atoms. The reaction product contains both sulphur and chlorine, and is present in the oil in sufficient amount to increase its load-carrying capacity.

H. G. Berger, D. E. Badertscher, and F. M. Seger. U.S.P. 2,247,046, 24.6.41. Appl. 23.10.40.—An extreme-pressure lubricant in which is admixed a small amount of the product obtained by the reaction of perchloromethylmercaptan with a compound of the general formula *RSX*. *R* represents a radical selected from the group consisting of alkyl, aryl, and alkaryl radicals, and *X* represents an element selected from the group consisting of hydrogen and metal.

M. T. Flaxman. U.S.P. 2,247,577, 1.7.41. Appl. 14.3.38.—Preparation of a lubricating oil containing 1–10% of an oil-soluble aluminium soap, and from 0·5 to 3% of an organic normally liquid amine having high vapour pressure at normal temperatures and having also fluidizing and spreading properties for the oil–soap mixture.

U. B. Bray and D. E. Carr. U.S.P. 2,247,475, 1.7.41. Appl. 23.11.36.—Production of an over-refined low-V.G.C., highly paraffinic lubricating oil containing an added petroleum-extract fraction obtained from a petroleum lubricating oil stock. The extract fraction is soluble in selective solvents for non-paraffinic materials of the petroleum lubricating oil stock, and is of relatively high molecular weight and of aromatic character. It has a gravity of the order 13–18° A.P.I., and is present in sufficient quantity to impart freedom from substantial corrosive and ring-sticking tendencies.

W. A. Smith. U.S.P. 2,247,927, 1.7.41. Appl. 11.4.38.—Removal of impurities from petroleum lubricating oils and motor and petroleum heating fuels, increasing their colour stability and reducing tendency to gum and sludge formation. The process consists in simultaneous treatment with concentrated sulphuric acid and an aryl amine.

R. Bulkley, L. A. Hamilton, and V. A. Kalichevsky. U.S.P. 2,248,848, 8.7.41. Appl. 24.1.39.—Preparation of a lubricating oil which is relatively stable against the formation of acidic products of oxidation. The composition consists of a completely refined lubricating oil, initially free from acidic constituents, and a small amount of oil-soluble sulphonic acids derived from the treatment of lubricating-oil fractions with sulphuric acid.

B. H. Lincoln, W. L. Steiner, and A. Henriksen. U.S.P. 2,248,925, 15.7.41. Appl. 29.3.39.—Preparation of a lubricating composition consisting of a major proportion of lubricating oil and a minor proportion of a halogen-bearing aromatic amine.

W. A. Smith. U.S.P. 2,249,333, 15.7.41. Appl. 10.5.38.—Method of improving lubricating properties of an oil without materially thickening it. The oil is brought into contact with air for a period of time dependent on the temperature of the oil and the efficiency of contact between the air and the oil, and in any case until samples show that approximately maximum film strength has been obtained. The oil is then immediately cooled.

E. Lieber. U.S.P. 2,249,564, 15.7.41. Appl. 15.7.38.—Preparation of an improved lubricant consisting of a mineral lubricating oil and a ketone of the following formula:—

$$R - \underset{\underset{O}{\|}}{C} - R'$$

R is a naphthenic radical having a molecular weight at least as high as that of the naphthenic radicals obtainable from kerosine, and *R'* is a closed-ring radical selected from the group consisting of polynuclear aromatic hydrocarbons and alkyl hydrogenated, oxy-, and nitrogen derivatives of aromatic hydrocarbons.

E. Lieber. U.S.P. 2,249,565, 15.7.41. Appl. 21.6.39.—Improved lubricating oil ingredients consist essentially of naphthenic ketones in which polycyclic radicals are combined with naphthenic acyl radicals of petroleum naphthenic acids.

E. W. Cook and W. D. Thomas. U.S.P. 2,249,626, 15.7.41. Appl.13.3.41.—Preparation of a lubricating oil composition containing a 2 : 4-dialkylphenol sulphide in amounts sufficient to exert sludge-dispersing properties under heavy duty service without increasing bearing corrosion.

L. A. Mikeska and E. Lieber. U.S.P. 2,250,545, 29.7.41. Appl. 19.10.38.—Preparation of a lubricating composition consisting of a mineral lubricating oil and from 001 to 10% of a soluble organic xanthogen tetrasulphide.

J. M. Musselman and H. P. Lankelma. U.S.P. 2,251,686, 5.8.41. Appl. 28.9.39.—Preparation of a lubricant consisting of an oil of lubricating viscosity to which has been added a small amount of the product of reacting carbon disulphide with an amine, and reacting the product thereof with sulphur in order to combine at least three atoms of total sulphur.

B. H. Lincoln and A. Henriksen. U.S.P. 2,251,738, 5.8.41. Appl. 24.8.38.—Preparation of a lubricant consisting of a major proportion of a lubricant base and a minor proportion of a chloro phthalic acid.

M. S. Arguss, G. W. Ayers, and H. Schindler. U.S.P. 2,251,774, 5.8.41. Appl. 28.12.39.—In order to reduce the pour test of lubricating oils, an additive is used consisting of the condensation product of halogenated paraffinic hydrocarbon and hydrocarbon resin obtained from partly spent decolorizing adsorbent.

F. M. Watkins. U.S.P. 2,252,793, 19.8.41. Appl. 27.3.40.—Preparation of a lubricating composition consisting of a petroleum lubricating oil, 0·5–2·5% of basic calcium phenyl stearate, 0·5–3·0% of a solubilizer, and 0·5–1·0% of a thioamid.

J. E. Schott and L. R. Churchill. U.S.P. 2,253,399, 19.8.41. Appl. 5.4.38.—Preparation of a substantially liquid and non-stringy lubricating oil, particularly suitable for use in diesel engines. The oil consists of a hydrocarbon motor oil of suitable viscosity heated with approximately 1% by weight of aluminium stearate and from 5% to 20% by weight of the aluminium stearate of triethanolamine. The resultant oil has improved lubricating properties, but maintains viscosity and fluidity characteristics of the uncompounded oil. H. B. M.

Asphalt and Bitumen.

1185. Specification for Asphalt Enamel Protective Coatings for Steel Water Pipe. Anon. *Asphalt Institute Construction Series*, No. 55, 1941.—Specifications for asphaltic primer, asphaltic dip, asphaltic enamel, and bitumen-saturated asbestos-felt wrappers for protective coatings for steel water-pipe are given, together with methods of application of the materials and methods for determination of performance characteristics of the enamel. The performance tests are made on specimens prepared on mild-steel plates to which the enamel has been applied after sand blasting and treatment with primer. The tests comprise high- and low-temperature sag tests, peel test, impact tests, soil-stress resistance, and solubility test. A. O.

1186. Required Thickness of Asphalt Pavement in Relation to Subgrade Support. P. Hubbard and F. C. Field. *Asphalt Institute Research Series*, No. 8, 1941.—The paper gives curves for determining the thickness of asphaltic concrete surfacing required to carry wheel loads of 60–90 lb. per sq. in. on soils of different supporting values, as determined by the method described in Research Series No. 7. A. O.

1187.* Asphalt and its Constituents. R. R. Thurston and E. C. Knowles. *Industr. Engng Chem.*, 1941, **33**, 320.—The purpose of this paper has been to present the results obtained in an investigation of the photoxidation sensitivity of constituents which are commonly known to be present in asphalt. The asphalts used were separated into five main fractions :—

(*a*) asphaltenes, by means of pentane ;
(*b*) resin by means of propane ;
(*c*) wax by means of methyl ethyl ketone–benzene solution ;
(*d*) paraffinic and naphthenic constituents by extraction with acetone in an equilibrium extraction tower.

Extensive tests on these constituents indicate that they represent characteristic fractions of an asphalt.

Three petroleum residua were employed in the work, and the yields and some tests on one of them (Mexican asphalt of 257 penetration at 77° F.) are given in the following table :—

Constituents from Mexican Asphalt.

	Asphaltene.	Resin.	Naphthenic Oil.	Paraffinic Oil.	Wax.
Yield, %	25	25	26	21·5	1·3
C–H ratio	10·7	8·46	7·7	6·87	6·52
Mol. weight	1800	1215	390	730	625
Softening point °F.	decomp.	147	liquid	liquid	122
Kinematic viscosity, C.S.					
210 °F (98·9 °C.)	solid	—	18	67	37
100 °F (37·8°C.)	solid	skin / solid	468	2300	solid
Viscosity-gravity const.	—	—	0·935	0·864	0·812

All the constituents absorbed oxygen, the resin and naphthenic oil being more readily oxidized than the remaining constituents. Constituent source was also a factor. Part of the absorbed oxygen was eliminated as water and carbon dioxide, and all residues showed an increase in weight.

The results obtained are, however, incomplete, particularly with respect to information relative to changes in the asphalt or constituents which accompany the photoxidizing action, and also on the effect of temperature on the rate of the photoxidizing action.

The data obtained are significant in showing that all of the constituents normally present in an asphalt are susceptible to photoxidation; whilst the resistance to photoxidation may be somewhat increased by selection of asphalt source, it is more important to protect an asphalt surface, as far as possible from exposure to sunlight.

H. E. T.

1188.* Performance Tests for Bituminous Emulsions. L. G. Gabriel and W. L. Peard. *J. Soc. chem. Ind.*, 1941, **60**, 78–84.—The difficulty of devising tests for performance of emulsions on the road is emphasized, and it is stated that no test can be used as the basis of a specification to give satisfactory results, owing to the effect of temperature and humidity on the evaporation of water from the aqueous phase. The defects of previous performance tests and the lack of correlation with actual road trials owing to difficulty in carrying out the latter are discussed. The authors suggest the use of small-scale "imitative" road tests, which could be expected to give good correlation with road results. They have, in fact, found that two tests: (1) the model road, and (2) the Setting Performance test, satisfy these conditions with reasonable accuracy. Primarily the stage to which the emulsion is allowed to proceed is defined as (*a*) setting and (*b*) binding; (*a*) refers to the stage when the particles adhere together to give a "coagulum," and (*b*) to the later stage when adhesion or otherwise occurs. Test (1) is made on a circular track, the mean radius being 21 in. and width of test 8 in., and this gives reasonable wear in 2–4 hr. The emulsion is allowed to set for ½ hr. before testing. The percentage of total chippings retained is estimated. Test (2) consists of preparing an aggregate surface on a plate, followed by application of emulsion, blinding with chippings, and after setting for various periods of time, attempting to remove loose chippings with a special "comb-tool." The percentage area remaining covered after a given time is estimated. The setting characteristics are obtained by plotting these areas against the setting time, and the area enclosed by this "plot" is expressed as a percentage of the maximum possible area, representing 100% adhesion. The method is more satisfactory as a comparative than as an absolute method. The main factors producing the set of the emulsion on the road are: (1) evaporation, (2) lability, and (3) the coagulative effect of the stone aggregate. It is pointed out that the lability number itself does not give a measure of the setting time, and to do this cognisance must be taken of the original composition of the emulsion. A method of estimating the setting time from the lability value depends on the assumption that all emulsions dry at the same constant rate down to the water content of the lability value. It has been found that considerable differences in the lability value are obtained with some emulsions after contact with aggregate, and these values may not give a true index of behaviour on the road. It is shown that rolling has a considerable effect in hastening coagulation of bitumen, and that coagulation by stone is not electrolytic in character, but is produced by adsorption of soap and alkali from the emulsifier solution and consequent local coagulation of the bitumen. This coagulated bitumen is very permeable to the aqueous phase of the emulsion, and thus coagulation can proceed further. The unsatisfactory features of the Weber and Bechler test are discussed, and a new stone coagulation test is described in which the ratio of emulsion to stone is similar to that used in large-scale practice. The test consists of application of stone to a coating of emulsion on the bottom of an air-tight tray, followed by washing out the uncoagulated emulsion after 4 hr. and estimation of the percentage of bitumen coagulated. No single simple test gives direct correlation with road performance, but it is suggested that the combination of this latter test and the existing lability test, and the establishment of road correlation, would eventually place the position of performance tests for road aggregates and emulsions on a satisfactory footing.

H. G. W.

1189.* Addition Agents in Asphalt Improve Road Construction. Anon. *Nat. Petrol. News*, 27.11.40, **32** (48), R. 434.—The coating of mineral aggregates by asphaltic bitumen has been improved by a number of methods which are of two classes. In the first the spreading of the binder over the stone surface is facilitated by the pretreatment of the stone with dilute aqueous solutions of the salts of heavy metals such as lead, iron, aluminium, etc., and in the second, the addition of dopes to the bitumen has the same aim. By both methods the water resistivity of the coatings is improved.

H. G.

1190. Patents on Asphalt. D. B. Harrison. U.S.P. 2,247,371, 1.7.41. Appl. 7.6.38.—Production of asphalt from petroleum residual oil containing less than 10% asphaltenes by contacting the residual oil with sulphur dioxide and air at a high temperature, so that reaction of the sulphur dioxide and air with the residual oil is effected. The treated residual oil is blended with high boiling oil rich in resins.

A. B. Hersberger. U.S.P. 2,247,375, 1.7.41. Appl. 16.12.37.—The melting point of a material of bituminous origin is increased by mixing it with a halogenated organic compound and heating to a temperature between 200° and 400° F. under superatmospheric pressure in the presence of an artificially introduced oxidizing gas. Afterwards the halogenated organic compound is removed by distillation. H. B. M.

Special Products.

1191.* Petroleum Becomes Source of Military Explosives. B. O. Lisle. *Refiner*, Aug. 1941, **20** (8), 294–300.—Chief of the explosives obtained from petroleum is trinitrotoluol. There is a number of other explosives which can be and are used in various ways, but trinitrotoluol is generally preferred because of its high power, great stability and dependability, and safety during handling. It is of especial value for use in munitions, as it can be used alone or mixed with other explosives, whilst its superior stability permits much longer storage of the shells or bombs.

The elementary chemistry of toluene is given, together with its physical properties. This is followed by a brief outline of the chief processes used for the synthesis of toluene. Simple fractionation of a crude such as that obtained from Borneo has already proved itself to be one of the cheapest, easiest, and most satisfactory sources of toluene for manufacture of explosives in the past, and there is no reason to doubt its effectiveness at present. With slight adaptation, existing petroleum distillation apparatus can be employed to treat this raw material with every satisfaction. Such apparently is the type process to be employed in the new toluene plant of the Shell Oil Co. at Houston. Another possible process to be used by this Company appears to involve radical changes in other hydrocarbon molecules. The process is not specified. Nitration is discussed.

It is also possible to produce an appreciable quantity of toluene at the Texas City plant of Pan American Refining Corporation by means of the new hydro-reforming unit constructed there. Although designed with a view to producing a wide range of high octane gasolines, typical charge and product inspections show substantial increases in octane number and volatility with a slight decrease in gravity, and thus indicate the presence of aromatics. Further analysis is understood to have shown an aromatic content of 40–50% of the product, and from 15% to 20% of the aromatics present are toluene, the balance consisting primarily of xylenes and higher homologues.

In addition to petroleum as a source of toluene, it has been reported that the discovery of a cheap method for producing high explosives from natural gas introduces a new potential source of earning power for natural gas producers. Said to be comparable to nitroglycerine, now utilized in dynamite and double-base military powders, the gas-derived explosive would use only a small fraction of total natural gas production even to fill war-time needs. Since the return/unit of gas utilized apparently would be considerably higher than in ordinary industrial or home consumption, several producers are said to be studying the large-scale application of the new process.

According to the American Petroleum Institute, chemists are using 350,000,000,000 cu. ft. of gas/year as a reactive agent between nitromethane and formaldehyde, to

form a product that can be acted upon by nitric acid to make a new explosive more stable than T.N.T.

An official statement made by the chief of Manufacturers for the National Defence Advisory Commission regarding the practicability of obtaining toluene from petroleum is quoted at the end of the paper. A. H. N.

1192.* Carbon as a Material of Construction. M. J. Dorcas. *Refiner*, Aug. 1941, **20** (8), 311–313. *Paper Presented Before Western Petroleum Refiners Association.*—The term "structural carbon" refers to solid pieces of elementary carbon of either the crystalline graphite or the so-called amorphous forms. Like ceramic articles, many minor variations of grades, each with different properties and applications, are known. These variations of properties exist because of the use of different raw materials and varying methods of manufacture.

The basic raw material is some form of elementary carbon, such as coal, charcoal, lampblack. Usually petroleum coke is the starting-point. This basic carbon material is ground and sorted and mixed according to particle size with pitches and tars. The heated plastic mass is then formed by pressure—that is, extruded or moulded to the approximate shape and size of the desired finished piece. The "green" piece is then baked under suitable controlled conditions in a reducing atmosphere at a temperature much higher than a "red heat." The pitches and tars are thus carbonized or charred, leaving the entire piece in the original size and shape, and all of one solid, dense, hard, black, homogeneous piece of elementary carbon that might be called "black ceramic material." These carbon pieces, if heated to the maximum temperatures of the electric furnace, undergo a molecular metamorphosis and become graphite. Carbon and graphite are both elementary carbon—but are allotropic forms of the same element with different physical properties.

Carbon so prepared in pieces which may vary in weight from ¼ gm. to 10 tons is similar in some ways to ordinary ceramic material. It can be used for construction purposes much as ceramic or earthenware materials are. This raw material has some porosity similar to unglazed earthenware, and if used for pressure vessels some seepage of liquids may result.

The physical properties of the structural carbons usually made are described. These properties logically lead to a wide application. Carbon Raschig rings and bubble-caps withstand most acids and alkalis indefinitely. They do not soften with time nor do they spall due to thermal shock. Carbon bricks are used in a multitude of structures (*e.g.*, pickle-tanks and vats and digestor linings, ducts and furnace and ladle linings, pipe and fittings, including valve handles), for almost all corrosive solutions, including hydrofluoric acid. Pipe of graphite promotes high-efficiency evaporators and heat exchangers that give no metallic contamination to the materials handled. Mould-plugs, stopper heads, and sintering trays find metallurgical applications. Entire towers and plants for gas purification treating, distillation, etc., are made of carbon. They vary in size from ½-in. Raschig rings to Cottrell electrostatic precipitator towers constructed entirely of carbon and weighing half a million pounds.

The paper concludes with a study of specific applications of structural carbon to the petroleum industry—chiefly as tower packings, catalyst carriers, heat-exchanger parts, etc. An interesting application is as piston-rings, as graphite itself needs no lubrication in gas or liquid pumps in which hydrocarbon lubricants cannot be used.

A. H. N.

1193. Patents on Special Products. E. D. Stirlen. U.S.P. 2,246,552, 24.6.41. Appl. 6.12.39.—A fuel composition, consisting for the most part of normally fluid, readily inflammable hydrocarbons, is prepared by adding a sodium soap to the hydrocarbons. The sodium soap is only partly soluble in the hydrocarbons and adapted to congeal them. Thereafter an organic solvent for the hydrocarbons and the soap is added in sufficient quantity to bring the two components of the mixture into solution. Finally the solvent is removed by distillation and the residual hydrocarbon soap mixture thus solidified.

M. de Groote. U.S.P. 2,246,842, 24.6.41. Appl. 27.6.40.—Process for breaking petroleum emulsions of the water-in-oil type. The mixture is subjected to the action of a demulsifier consisting of a surface-active, positive, ion-containing amine charac-

terized by the fact that there is directly linked to an amino-nitrogen atom at least one hydrocarbon radical containing the carbon atom chain of an acyl radical of a detergent forming monocarboxy-acid, having more than 8 carbon atoms and not more than 32 carbon atoms. The amine is further characterized by freedom from acyl radicals, nitrogen-linked aryl radicals, and aliphatic radicals in which ether linkages occur at least three times.

L. T. Monson. U.S.P. 2,246,856, 24.6.41. Appl. 26.11.40.—Process for breaking petroleum emulsions of the water-in-oil type by subjecting the emulsion to the action of a demulsifying agent. The agent consists of a mixture of an acylated amino-ether containing a radical derived from a basic hydroxyamino-ether, also an acyl radical derived from a detergent-forming monocarboxy-acid, and a blown fatty oil, the ratio of the former to the latter being 9 : 1 to 1 : 9.

W. Herbert. U.S.P. 2,247,087, 24.6.41. Appl. 13.12.37.—Improvements in the catalytic conversion of gas mixtures containing carbon monoxide and hydrogen. Steps in the process comprise, in combination, application of super-atmospheric pressure, indirect cooling of catalysts, passing a solvent over the catalysts to free them from the paraffin which is formed, and recycling at least part of the end gas of the synthesis.

J. R. Averill. U.S.P. 2,252,957, 19.8.41. Appl. 6.9.40.—Production of petroleum sulphonates by subjecting non-pretreated crude petroleum, petroleum distillate, petroleum mineral oil, and mineral oil extract to the following processes :—

(*a*) A sulphonation–polymerization step.
(*b*) A washing step.
(*c*) A neutralization–alcoholic solvent step.
(*d*) Separation into a three-layer system consisting of unreacted oil, an aqueous alcohol solution of petroleum sulphonates, and concentrated salt brine. The unreacted oil and salt brine are then withdrawn.

J. T. Rutherford and R. J. Miller. U.S.P. 2,252,984, 19.8.41. Appl. 6.5.39.—Preparation of a compound consisting of a hydrocarbon oil and a polyvalent metal salt of a sulphur containing substituted acid of phosphorus having an organic constituent therein. The salt is present in sufficient amount to inhibit deterioration at elevated temperature.

J. T. Rutherford and R. J. Miller. U.S.P. 2,252,985, 19.8.41. Appl. 6.5.39.—Preparation of a composition consisting of a hydrocarbon oil and an alkaline-earth metal salt of a sulphur-containing substituted acid of phosphorus having an organic constituent therein. The salt is present in sufficient amount to prevent deterioration of the oil at high temperatures.

L. T. Cantrell and J. O. Turner. U.S.P. 2,253,227, 19.8.41. Appl. 5.9.36.—Preparation of an oil-soluble organic phosphorus compound suitable as an improvement agent for hydrocarbon oils. An olefin and a phenol are reacted in the presence of sulphuric acid, and at least part of the resultant product is treated with phosphorus trichloride to obtain a final inhibitor product containing 1–5% phosphorus.

L. T. Cantrell and J. O. Turner. U.S.P. 2,253,228, 19.8.41. Appl. 15.9.36.—Preparation of an oil-soluble organic sulphur compound suitable for use as an improvement agent for hydrocarbon oils. A sulphur chloride is reacted with a water-insoluble reaction product of a phenol and an olefin having anti-oxidant properties when added to a hydrocarbon oil. The reaction is carried out to such an extent as to cause sufficient sulphur to be incorporated in the final product to give it the property of inhibiting the corrosion of bearing metals by hydrocarbon oil. In addition, the improvement agent retains to a substantial extent the anti-oxidant value of the phenol–olefin reaction product. H. B. M.

Detonation and Engines.

1194.* Engine Bearings. W. D. B. Brown, P. T. Holligan, and J. W. Warrington. *Auto. Engr*, March 1941, **31** (408), 83–88.—Operating conditions demand certain conflicting properties in the bearing metal. High load-carrying capacity demands

high compressive strength; this entails high hardness, which is not altogether desirable. The softer alloys suffer a marked decrease in hardness and strength at high operating temperatures. Two important properties are "embeddability" and "conformability." The former is the ability to engulf minute foreign particles by local flow without causing high spots and overheating. This property appears to demand low yield stress and low hardness. "Conformability" is the ability to yield under local pressure, so eliminating local overstressing. High ductility is conducive to this, because it allows the metal to yield without cracking.

A bearing material should thus possess the following, somewhat incompatible, mechanical properties:—

(*a*) Low coefficient of friction.
(*b*) Low hardness for maximum "embeddability."
(*c*) High ductility for maximum "conformability."
(*d*) High compressive strength for maximum load-carrying capacity.

Since all these requirements cannot be met by any one metal, the final choice of materials for a particular application must be based on consideration of all the relevant factors.

For highly loaded bearings there has been a tendency towards the use of thin white-metal linings in a steel shell, the thickness of the babbit being of the order of 0·020 in. Ultra-thin linings are shown to have advantages, and a white-metal lining of 0·005–0·008 in. is considered ideal for many purposes. Where conditions call for a fairly high loading and a fairly good degree of embeddability, a tri-metal bearing may be used. This has a layer of lead bronze between the steel and white-metal.

The provision of correct bearing clearance is of major importance, particularly in high-speed engines. Too great a clearance causes pounding, and sometimes crankshaft distortion. Inadequate clearance restricts oil circulation, and therefore causes overheating and breakdown of the oil film. As a guide to correct clearance with pressure lubrication, 0·00075 in. per inch of bearing diameter is recommended for white-metal, and 0·00125 for copper–lead bearings.

In fitting thin-walled bearings an important factor is interference fit or "nip" (the amount by which the peripheral length of a half-bearing exceeds the semi-circumference of the bore of the housing into which it is to be fitted). A high proportion of bearing failures—often attributed to faulty adhesion of the white-metal—is attributable to movement of the bearing in its housing; this may be largely obviated by correct "nip." The degree of nip required in a particular application is best determined by experiment.

Pressure per unit of projected area is not a complete criterion of the pressure an oil-film will carry. For two bearings of equal projected area, that possessing the higher length–diameter ratio has two advantages: the lower rubbing speed causes less temperature rise, which may have an appreciable effect on bearing life, and the rate of drop of oil pressure between the supply point and the end of the bearing will be lower. With pressure lubrication, grooves are not required to spread the oil in the bearing, and they should be dispensed with wherever possible. The injudicious use of grooves and oil-feed holes provides escape points which may adversely affect bearing life.

The hardness, rigidity, and surface finish of crankshafts in relation to bearing materials are discussed, and the importance of oil cleanliness in relation to scoring of the bearing surface is emphasized. Main-line filtration, in preference to a by-pass filter, is advocated at least during the running-in period. The authors consider that engine tests are the only satisfactory criterion of the suitability of new bearing materials.

K. A.

1195.* Oxygen-boosting of Diesel Engines for Take-off. P. H. Schweitzer and E. R. Klinge. *Engineer*, **172**, 1941, 90–92.—Tests were carried out with a C.F.R. four-stroke diesel engine unit to examine the effect of feeding to the air intake additional oxygen up to a total concentration of 55%. Combustion phenomena were examined by means of an ignition-lag indicator with electromagnetic pick-up units fitted in the combustion chamber and fuel-injector, also by the use of a cathode-ray oscillograph. Two main series of tests were carried out, one at a fixed timing of 4° advance, and the other under optimum timing conditions. The similarity of both sets of results showed fuel timing to be a relatively unimportant factor.

The B.H.P. was increased by 60% from 2·9 to 4·65 at 890 r.p.m. and the B.M.E.P. rose from 100 to 150 lb./sq. in. as the oxygen concentration was increased from the normal 21% to 45%. Beyond 40% oxygen the power increase was insignificant, and at 55% it approached zero. Maximum cylinder pressures and specific fuel consumption rose with added oxygen, although the foregoing power increase was achieved with only an additional 80 lb./sq. in. maximum cylinder pressure and a 25% higher fuel consumption. The maximum rate of combustion pressure rise and the ignition lag decreased generally with increasing oxygen content.

In conclusion, the possibilities of applying oxygen-boosting to assist the take-off of diesel-engined aircraft are examined. Based on the assumption of 6000 cruising h.p. and an engine weight of 2 lb. per h.p., a saving in engine weight of 4000 lb. could be effected, since the additional 33% power assumed as required for take-off could be obtained by feeding oxygen into the air intake. E. F. C.

1196.* Method for Measuring Diesel Fuel Ignition Lag. A. E. Traver and W. S. Mount. *J. Soc. aut. Engrs*, 1941, **48** (5), 177–179.—The instrument described was designed to measure the delay period or ignition lag with the greatest possible accuracy. The device can be applied to any diesel engine where the injector can be fitted with an electrical pick-up or mechanical contactor, and where an outlet is provided in the combustion chamber for pressure measurements. The meter is essentially an electronic switch, which is turned "on" by the voltage impulse from the first closure of the injection contact points and is turned "off" by the first closure of the combustion contact points. It differs from other devices of this type in that cycle-to-cycle variations of lag are averaged by a condenser which is charged during the "on" period and continuously discharged through a micro-ammeter. Cyclic fluctuations in the point at which injection commences relative to crank angle, are compensated by starting the measuring period by means of the pickup attached to the injection valve. An adjustable zero-depressing arrangement in the meter circuit enables the full scale-range to cover a variation of only two degrees lag within the range of the fuel being tested. K. A.

1197.* Requirements of a Smokemeter. K. M. Brown. *J. Soc. aut. Engrs*, 1941, **48** (5), 188–192.—The ability to evaluate the density of the smoke in the exhaust of a diesel engine is becoming increasingly important. Various methods of measuring smoke are discussed. The light-absorption, photo-electric cell, sampling type of meter is considered to be the most satisfactory. The requirements of a satisfactory meter are listed and an instrument described which seems to fulfil them fairly adequately. Principal features are the unusually long measuring tube, the use of a flashlight bulb with reflector for a light source, and a vacuum pump to draw the sample through the tube.

It is pointed out that a measurement of smoke should be independent of the smokemeter used, and a scale, based on light absorption per unit length of smoke-column, is proposed. Acceptance of this scale should enable smoke-readings to be similarly interpreted by everyone. K. A.

1198.* 1940 Road Detonation Tests. J. M. Campbell, R. J. Greenshields, and W. M. Holaday. *J. Soc. aut. Engrs*, 1941, **48** (5), 193–204.—This paper was compiled from the Report of the C.F.R. Committee on a programme of co-operative road tests. These indicated that the A.S.T.M. octane number alone, or even a road octane number as determined by methods heretofore widely used, does not give sufficient information for present needs relative to fuel behaviour in service. Neither do test methods previously used provide sufficient information concerning the fuel requirements and knocking characteristics of engines.

A new method has been developed, in which the spark advance corresponding to incipient or border-line knock is determined for the fuel under test at frequent increments of speed; these observations were made on a range of cars during full throttle acceleration on a slight upgrade, using twenty-three representative fuels as well as the necessary range of reference fuels.

For each car these spark advance readings are plotted against speed, both for the reference and test fuels. By interpolating the test fuel data on the reference fuel

framework the octane number of the test fuel can be determined at any desired speed. Also, by plotting a previously determined curve of spark advance for maximum power and the characteristic curve of the distributor automatic advance it is possible to determine (1) the car octane requirement over the whole speed range, and (2) to what extent a given fuel meets the car's requirements.

In order to evaluate fuels of high anti-knock quality it has often been the practice to advance the ignition timing beyond that for maximum power. Tests with low- and high-compression heads showed that such a rating is not necessarily indicative of the performance in an engine designed to utilize the fuel effectively.

A summary of the ratings obtained by the new border-line knock method on the twenty-three representative fuels is presented, and the applications of the method to fuel and engineering development are briefly discussed. K. A.

1199.* New High-Altitude Fuel System for Aircraft. W. H. and R. R. Curtis. *J. Soc. aut. Engrs*, 1941, **49** (1), 260–265.—The increased rate of climb of modern aircraft and their ability to fly at very great altitudes have accentuated vapour-lock problems. During a climb of 36,000 ft. the atmospheric temperature falls some 90° F., but the fuel temperature within the tanks may fall only about 10° F. Consequently, so much air and gas are released that, in ordinary fuel systems, vapour lock occurs at relatively low altitudes. Laboratory tests designed to simulate flight conditions have not entirely reproduced actual performance. It is believed that observed differences may be due to the effects of vibration in the aircraft.

Some conventional fuel systems are described. Analysis of their shortcomings led to the development of the Thompson Booster Pump. This is a modified centrifugal pump attached directly to the fuel tank and driven by an electric motor. By delivering fuel under pressure from the tank to the pump on the engine it enables fuel entering the suction side of the latter pump to be kept free from released vapour and air. An incidental advantage of the booster is that it facilitates priming of the fuel system before starting the engines. K. A.

1200.* Spontaneous Ignition of Hydrocarbons. C. W. Sortman, H. A. Beatty, and S. H. Heron. *Industr. Engng Chem.*, 1941, **33**, 357.—Spontaneous ignition temperatures in air, and the corresponding time-lags, have been determined for a variety of hydrocarbons at atmospheric pressure by the oil-drop method. This method is due to Moore, and employs a steel crucible so arranged that varying air rates and oil-drop sizes may be employed.

Under some conditions of air and oil-drop size, the easily ignited hydrocarbons, such as cetane and heptane, show two separate temperature zones of non-ignition above the minimum ignition temperature, a phenomenon not previously recorded in the literature; under other conditions one or other of these non-ignition zones are eliminated.

The conditions of air and liquid feed have a marked effect on the ignition time lag, especially at low temperatures. Addition of tetramethyl lead completely inhibits igniting up to about 850–1000° F. (454–538° C.). H. E. T.

Economics, Statistics and Education.

1201.* Petroleum and the War. R. E. Wilson. *Bull. Amer. Assoc. Petrol Geol.*, July 1941, **25**, 1264–1282.—The author of this interesting paper, particularly in view of its present-day importance, discusses the various branches of the industry from production to refining-production of 100-octane aviation gasoline, lubricating-oil requirements, heavy fuel oil for the Navy, transportation storage problems as found in the U.S.A. to-day, and compares the situation from the standpoint of the incomparably smaller petroleum reserves of Europe. It is pointed out that Germany and Italy have been carrying on their war operations, plus the industrial, agricultural, and civilian activities of these two countries, and also the occupied territory of Western Europe, with a total production of petroleum products, including synthetic products and imports, equal to only about 5% of the U.S.A. production of crude or consumption of refined products.

The policy of proration in the U.S.A. of the production branch of the industry is well prepared for any emergency, particularly in those States where sound conservative principles have permitted the building up of tremendous underground reserves available for any emergency at a moment's notice and without undue drilling of new wells Refining capacity, whilst able to meet increases, is not quite as great as is production. Increased capacity for manufacture of 100-octane aviation gasoline as announced, whilst able to meet demands for the next 15–18 months, owing to installation of synthetic capacity equivalent to nearly twice home and foreign demand, increased expansion is required to meet every possible contingency in view of the very wide increase in aerial transport with development of programmes in hand. Lubricating oil requirements are sufficient, as increased home demand is balanced by loss of foreign markets. Reduction in number of Specifications (different) now in use will simplify the problem of supply.

In regard to heavy fuel oil for the Navy, stocks are sufficient for a naval war in the Pacific, but for a possible major effort in the Atlantic substantial stocks must be built up. Transport facilities in existing pipe-lines are at present sufficient and can take care of any reasonable expansion, but, if allowables of crude production are increased, new lines are required to get the crude to the refinery capacity available. Gasoline transportation by tank-car and pipe-line in the interior of the country appears to be capable of handling increased loads without difficulty. Tanker tonnage from west to east is inadequate, although twenty-five large tankers are due for completion this year—pipe-lines, however, may have to be laid into south-east if legal obstacles and obstructions can be overcome. Underground storage facilities, in exposed places, for aviation gasoline and fuel oil, as required by the two Services is being urged.

The author in his analysis of the Axis Powers reserves or supply position is definitely of the opinion that they are short of oil, and explains the large amount of preparation and storage arrangements required to permit a "blitz" on England, and considers that Italy is more of a liability to Germany than an asset; that demand for oil affects her industrial facilities, and that once England achieves air superiority enough to permit long range bombing and destruction of synthetic plants—invasion might not be required for England to win the war. R. J. W.

1202.* Fuel and War. F. C. Sheffield. *Auto. Engr*, March 1941, **31** (408), 89–91.—The author strongly advocates immediate and intensive development of all available means for the replacement of imported liquid fuel by home-produced alternatives. In deploring the lack of large-scale development before the war he alleges obstruction by technical as well as official bodies. He considers that the post-war economic position of Great Britain will not permit the unrestricted importation of foreign fuel, and therefore contends that gas-producers should not be regarded as a "conversion" measure. German methods of persuading the population to give preference to home-produced fuels and to practise domestic economy are recommended for adoption in this country. K. A.

1203.* Steam *versus* Diesel-electric Locomotives. E. E. Chapman. *Engineer*, **172**, 1941, 101–103.—The general dimensions and power performances of certain American diesel-electric locomotives and comparable conventional steam locomotives are given.

Advantages claimed for the diesel-engined type are :—

- High thermal efficiency.
- Lower water costs.
- High degree of utilization—greater flexibility.
- Reduction of delay due to taking fuel and water.
- Higher sustained speeds.
- Lower stresses imparted to track structure.
- Dynamic braking.

Disadvantages are :—

- High initial investment cost.
- Lower life expectancy.
- Demand for higher degree of maintenance.
- Higher unit cost of fuel and higher lubrication costs.

In conclusion a *résumé* is given of the accomplishments of diesel-electric locomotives in main-line service. While it is not suggested that they will entirely displace the constantly improving steam locomotive in railway service, as more and more are built, unit cost should be reduced, so narrowing the present gap between relative initial investment costs. E. F. C.

1204. Crude Petroleum and Petroleum Products. Minerals Yearbook Review of 1940 with Final Statistics for 1939. A. G. White, G. R. Hopkins, H. A. Breakey, and A. T. Coumbe. *U.S. Bur. Mines*, Washington, 1941.—This report deals largely with the incidence of the present war on world markets for petroleum and its products during the year 1940. By the end of that year closing of French and Mediterranean markets, together with the effects of the British blockade, had cut off the flow of oil to practically all continental markets. Thus in the United States exports were reduced by 58 million brl. as compared with 1939, and imports increased by 24 million brl. It is pointed out that should this trend continue, it may happen that in 1941 there will be an approximate balance between exports and imports. In 1940 exports amounted to 131 million brl. and imports to 83 million brl.

Analyses of production figures during 1940 showed an increase of 87 million brl. in the United States, no apparent change in Russia, a decrease in Venezuela of 21 million brl., in Iraq of 5 million brl., and in Rumania of 3 million brl.

Stocks of gasoline in the United States at the beginning of 1940 were abnormally high in anticipation of a war export demand which, however, did not materialize. Stocks of distillate and residual fuel were, on the other hand, comparatively low.

Proved reserves of crude oil discovered and developed in the United States in 1940 amounted to 1,894,000,000 brl., thus pushing figures relating to reserves in sight or extractable by known methods to the new peak of 19,025,000,000 brl. There is, therefore, no imminent danger of exhaustion. Nevertheless reserves in relation to total demand on 1st January, 1941, represented only 13 years' supply, which is a drop from the number of years' supply in reserve the previous year. H. B. M.

1205. Developments in the American Petroleum Industry, 1914–19. H. C. Fowler. *U.S. Bureau of Mines, Information Circular*, No. 7171, June 1941.—Firstly the author of this paper warns readers against assuming too critical an attitude when reviewing the 1914–19 period of petroleum development. It must be remembered that in April 1917 America entered the World War, and thereafter every effort was made to produce more and more oil to meet the demands of the fleet, the American Expeditionary Force, domestic wartime activities, and needs of the Allies. The price of gasoline warranted expenditure on costly innovations and demand justified drilling on wildcat locations.

Nevertheless, it would seem that entrance of the United States into the war affected very little the upward trend of increasing scientific knowledge, already well begun. The conclusion is reached that whether or not America had joined the Allies, most of the new techniques of the period would have evolved at about their natural rate.

To gain some idea of the position of the industry during that period, it should be recalled that the value of then-called technology as an aid to scientific production had not yet been appreciated. Petroleum engineers had barely established a profession, and it was not until after the Armistice that the first United States Civil Service examination for "oil-recovery engineer" was held. In fact the average American oil worker, although skilled in drawing oil from proven deposits, had little use for geological deductions. He was a practical man, and had not yet learned to use or appreciate scientific methods as an aid to the solution of geological and engineering problems.

The American Petroleum Institute did not materialize until March 1919, and the Petroleum Division of the Bureau of Mines carried a tremendous load of responsibility. There were few technologists in the employ of the oil companies, and in consequence engineers of the Bureau were called upon to undertake what would now be considered the normal duties of company employees in addition to their basic studies.

The technical literature of the time reflected current opinion, hypotheses and deductions concerning the genetic source of petroleum and its accumulation, some writers supporting the organic theory of petroleum origin, others arguing from physical and geological observations that rock disturbances associated with volcanic action

presented the best explanation of the origin of petroleum. Intimately connected with this research was a desire to establish the genetic reason for the occurrence of salt domes.

At the beginning of the period drilling depths were relatively shallow, and surface structure the usual clue to the existence of underlying conforming structures. Well logs for the most part were inadequate and carelessly compiled, the chief argument against their systematization being that it was inequitable to compel a company to divulge private information which had cost large sums of money to acquire.

Cost of exploration during the period was approximately 20–25 cents a barrel, as compared with 10–12 cents in 1939.

While the reviewer makes no pretence to cover all developments in exploration, drilling, production, transportation, etc., in the American petroleum industry during these years, it is possible to gain from the report a well-founded conception of the status of all major departments of the industry at that time. Acquisition of additional or more detailed information regarding any particular phase of the industry will be facilitated by reference to the comprehensive bibliography appended to the report.

H. B. M.

1206.* Scope and Content of the Petroleum Engineering Curriculum. L. C. Uren. *Petrol. Tech.*, July 1941, A.I.M.M.E. Tech. Pub. No. 1350, 1–8.—Although a four-year course is usual in petroleum engineering, it is generally agreed that a longer academic training would be preferable. Probably the best plan would be a four-year undergraduate course, devoted mainly to the fundamentals, followed by a year or two of industrial experience, and then a fifth year spent on the study of some special aspect. Out of a total of 128 time units in the undergraduate course it is suggested that the following proportions should be used: mathematics 16, physics 12, chemistry 19, geology 19, drawing, surveying, and mapping 12, general engineering subjects 24, economics, English, public speaking 12, petroleum technology 14. It is believed that the student should be given a well-developed picture of the industry in which he proposes to seek employment, and this involves courses other than true fundamentals.

The courses for the undergraduate years are outlined, and typical specialized courses for the post-graduate year are given, covering engineering, administration and management, petroleum exploration, and research and development.

A closer liaison between colleges and oil companies is advocated, and each student should have some oil-field experience in his undergraduate years. G. D. H.

BOOK REVIEW.

Aircraft Engines. Vol. 2. By A. W. Judge, A.R.C.Sc., D.I.C., Wh.Sc., A.M.I.A.E., etc., Late Senior Technical Assistant, Air Ministry. Pp. 446, 354 illustrations and figures. Demy 8vo. Chapman & Hall, Ltd. Price 30*s*.

This publication, issued a few months subsequent to the first volume, is devoted in the main to the descriptive side, whereas the previous volume dealt chiefly with theoretical and experimental aspects of aircraft-engine design. Certain sections of the volume under review, however, treat on some problems of design and theoretical subjects not previously dealt with.

The author first discusses the factors governing the selection of the most suitable types of engines for various classes of duty, and includes comprehensive data on ratings and weights of British and American engines, and comparative figures showing average power output per unit frontal area for all types. Torque and balance as affecting the selection of various designs are discussed at some length, and this section includes tables comparing inertia and balance data for engines of practically every type and number of cylinders.

Nearly a third of the book is devoted to descriptions of specific engines, first dealing with various types in general, and later with many of the most widely used in each type-group in more detail. A considerable portion of this section describes the more unusual types, including the many experimental and other compression ignition engines.

About 50 pages are devoted to detailed information dealing with the design of several of the main components, including cylinders, valves and valve-gear, pistons, airscrew reduction gear, etc.

The chapter on engine lubrication deals with general principles, the conditions obtaining in different types of engines, and the problems associated with the cooling and filtering of the lubricant. Several typical lubrication systems are described.

The ignition and exhaust systems are dealt with in two separate sections, and in addition to considerations of general requirements, detailed descriptions are given of the most widely used ignition equipment and different types of exhaust systems.

Some of the methods of providing drives for the many items of auxiliary equipment in modern aircraft, either direct from the engine or indirectly by means of air-compressors, hydraulic pressure, or electrically, are described, and various methods of starting are also dealt with. The book concludes with a short description of modern methods of engine testing.

An extensive bibliography to the experimental and practical considerations of aircraft engines is of special value.

The book is well arranged and exceptionally well illustrated, and although the later types of engines coming into service at the time of publication could not be dealt with, for obvious reasons, a very valuable source of information is here provided for all those concerned with, or interested in, the theoretical and practical aspects of aircraft engineering.

Erratum. Page 191. Fig. 142. Curves *A* and *B*. *A* should be *B*, and vice versa.

C. H. SPRAKE.

BOOKS RECEIVED.

British Standard Symbols for Use on Diagrams of Chemical Plant. B.S.I. Specification No. 974—1941. Published by the British Standards Institution, 28, Victoria Street, London, S.W.1. Price 2*s*. net.

This booklet lists a total of fifty-eight symbols, standardized for use on diagrams of chemical plant, representing in the main basic units of equipment. For the purpose of representing a composite apparatus, two or more of the basic symbols may be combined. For example, a still may be indicated by the combination of the basic symbols for a closed tank, a heater coil, and a plate-column. The

recommended symbols are classified in two groups: those representing plant units where the feed or discharge is affected by gravity are placed in Group I, and must be drawn upright to be correct in appearance; those in Group II may be drawn in any position. No symbols are listed for electric motors, internal-combustion engines, line-shafts, or other units of power-generating equipment, with three exceptions—namely, a boiler, a steam-engine, and a turbine. These have been included because their live or exhaust steam is often employed for process purposes.

The fifty-eight symbols proposed are arranged in a table of five columns. Symbol number is given in column one, its description in column two, and group-number in column three. The symbol itself is illustrated in column four, whilst the last column gives an illustrated example of its use in a diagram. The pamphlet concludes with a diagram of a hypothetical plant, indicating the way in which it is intended that the symbols should be used.

The use of standard symbols in diagrams relating to chemical plant will undoubtedly be an advantage in the fields of chemical engineering and in industries concerned with the treatment of materials. The proposed signs are simple, clear, and mainly pictorial in character, resulting in a diagram which may be rapidly interpreted.

S.A.E. Handbook, 1941. Pp. 829. Published by Society of Automotive Engineers, New York; April 1941. $5.00.

The 1941 edition of the *S.A.E. Handbook* contains many new and revised standards, mainly relating to aircraft components. In the Lubricants Section additional information has been included on the method for estimating viscosity at 0° F. by extrapolation on A.S.T.M. Viscosity Temperature Charts D 341–39. Details are given of the maximum errors of the method with oils of different kinematic or Saybolt viscosities. A table has also been added showing ranges of kinematic, Redwood, and Engler viscosities corresponding to S.A.E. viscosity numbers. Other sections of the *Handbook* contain the code for tractor testing and tractor fuel specification.

Institute of Marine Engineers, Transactions, Vol. 52. Session 1940–41. Pp. 249. Published by the Institute.

This annual volume of *Transactions* contains three papers of particular interest to the petroleum industry: "*Oil Purifying with Continuous Lubrication*," by Prof. E. Forsberg, dealing with theoretical considerations affecting the efficiency of centrifugal separators; "*A Note on the Present Position of Modern Diesel Engines for Coasters, Fishing Craft, and Inland Waterway Ships*," by A. C. Hardy; and "*Marine Oil Burning*," by J. T. Tomlinson, dealing mainly with the engineering details of installation, arrangement of burners and pumps. A very interesting and long paper by Victor Dover deals with the subject of "*Marine Insurance*" from the point of view of the marine engineer.

Petroleum Development and Technology, 1941. *Transactions of the American Institute of Mining and Metallurgical Engineers*, Vol. 142 (Petroleum Division). Pp. 587. New York, 1941.

The technical papers, which occupy one-half of this annual volume, have previously appeared in *Petroleum Technology*, the quarterly publication of the A.I.M.E. Petroleum Division. The majority of them have therefore already been abstracted in *Journal of the Institute of Petroleum*. But it is valuable to have these papers collected together within the covers of a single book. Seven papers deal with production engineering, and fourteen papers with engineering research, more correctly described as physico-chemical researches, on muds, viscosity, capillarity, and phase behaviour.

The second half of the book is a statistical account of developments in the American fields (arranged by States) during 1940, and a necessarily brief summary of operations in other countries. Contributors to the latter section include Dr. Arthur Wade (Australia), G. S. Hume (Canada), Basil B. Zavoico (U.S.S.R.), and D. C. Porterfield (Venezuela).

Professor H. H. Power of the University of Texas contributes a short article on petroleum engineering education, describing the programme of a four-year course. The subject of refining is restricted to a short five-page summary by W. Miller.

The Drilling Equipment Directory, 1941–42. Petroleum Directory Publishing Co., Tulsa, Oklahoma.

The directory is a handsomely bound book dealing with drilling equipment under separately tabbed sections. The sections deal with general reference data (including tables of equivalents and formulæ); rotary bits of various types and functions; cable tools; casing; cementing; drill-stem equipment; electric-power service; engines; rotary fishing-tools; mud admixtures and testing; power-transmission components; slush-pumps; rotary system small equipments; slim-hole and exploration (rotary) rigs; steam-generating apparatus; valves and fittings; well surveying; and wire-line and cordage.

The illustrations are excellent and the information offered is readily attainable by the method of indexing and sectioning used.

The utility of the directory is enhanced by the inclusion in every section of summaries of recent papers and of A.P.I. Codes relating to the proper use of the various equipments catalogued and to the many problems encountered in drilling, fishing, cementing, and other oil-field operations. In fact, the directory will be found a useful handbook apart from its commercial value to the manufacturer, buyer, and designer alike.

A.S.T.M. Standards on Petroleum Products and Lubricants. September 1941. Pp. viii + 398. $2.00 per copy.

The 16th edition of this publication, issued annually by the American Society for Testing Materials since 1926, provides in compact form all the test methods, specifications, definitions, and charts developed through the work of A.S.T.M. Committee D-2 on Petroleum Products and Lubricants. The 1941 book includes sixty-nine methods of testing, eleven specifications, and two lists of definitions of terms. In addition, four proposed new methods, approved for publication as information and for comment, are given covering tests for neutralization number (by electrometric titration, and for crankcase oils), potential gum in aviation gasoline, and conversion of kinematic to Saybolt Furol viscosity. A revised diesel fuel-oil classification is also included.

Important new standards in the volume provide specifications for aviation gasoline and tests for knock characteristics of aviation fuels, standardized method of determining the ignition quality of diesel fuels, and procedures for testing the aniline point of petroleum products and for carbonizable substances in paraffin wax. During the year some thirteen standards were revised—full details are given in the annual report of Committee D-2 published in the compilation.

Copies of this 400-page book in heavy paper binding with two tables of contents, one listing the standards in order of numeric sequence, can be obtained from A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa., at $2.00 per copy, with a price of $1.50 in effect for ten or more copies.

A supply of the book is expected at the Institute's offices in Birmingham during December 1941, and will be obtainable at 10*s.* 6*d.* post free.

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Geology and Development.

1207.* Philippine Drilling to Continue with Heavy Rotary. T. P. Sanders. *Oil Gas J.*, 24.7.41, **40** (11), 18.—Geologically the Philippines are comparable in many respects to the Dutch East Indies. The stratigraphy is highly complicated by a great number of unconformities, and steep dips are common. Oil seeps occur on the Bondoc Peninsula. Here drilling difficulties have been severe. Eighteen years ago wells were drilled on the island of Luzon, but they are not believed to have been well located or sufficiently deep.

The Daanbantayan Peninsula of Cebu Island is a domal or anticlinal structure with 900 ft. closure and dips of about 16°. No oil-seeps occur in this area, but a tar-sand is found 25 ml. to the east on the island of Leyte, and on the west coast of Cebu, near Toledo, an oil-sand outcrops. At Daanbantayan a hole has reached 6010 ft., and is shut in awaiting heavier equipment. A well is being drilled at Bariti, 80 ml. to the south. G. D. H.

1208.* Several New Discoveries Boost Jackson County, Texas, Activity. F. L. Singleton. *Oil Gas J.*, 4.9.41, **40** (17), 22.—A semi-wildcat in the Texana gas-distillate field shows promise of opening the first crude production on that structure. The well is at 5780 ft., and has been cemented to test the Marginula at 5102 ft. It gave pipe-line oil in a brief drill-stem test. Texana was discovered by torsion-balance work, and in 1939 gas distillate was found at 5705 ft.

Jackson County has eleven oil- and gas-fields, eight of them discovered in the last two and half years. Although Miocene production was found in the Cordele field, the main objective is the Marginula-Frio, which is productive in nine of the fields. The producing depth is mainly 4700–6300 ft., but the basal Frio gives oil in one field at 7300–8600 ft. All the fields appear to be domal, with two or more producing sands.

West Ranch is the biggest field. Lolita is second and has three sands in the Frio. Francitas largely yields gas distillate from three sands at 7300–8600 ft. Ganado and West Ganado appeared small at first, but improved their status.

A map shows the location of the Jackson County fields, and a table gives the discovery date, formation, producing depth, number of wells, and daily average and cumulative production. G. D. H.

1209.* Well Logs and Field Data of Active Areas—West Central Oklahoma. Anon. *Oil Gas J.*, 4.9.41, **40** (17), 50.—The dominant features of this area, known as the Anadarko basin, are the Arbuckle–Wichita system of echelon anticlines in the south, and the Nemaha ridge on the east. All the important development between these old mountain systems has been along the edges, except for a few tests in the heart of the area and a small oil-well on the Binger dome in Central Caddo County. Even where there has been development, as at Cement and Chickasha, correlation has been very difficult because of complicated structural and stratigraphical conditions.

The first production on the north slope of the Arbuckle–Wichita system was at Cement twenty-five years ago, and that field has been developed sporadically. Twenty different formations are productive down to 6500 ft., and the production is 7500 brl. of oil/day, and 532,500,000 cu. ft. of gas/month. Chickasha, a related structure to the south-east, has been an important gas-producing area for many years. Many years ago shallow production was opened at Gotebo, and in 1939 the Hobart pool was discovered. Sayre gives shallow production. To the south-east, on a series of sharp folds south of the Arbuckle–Wichita mountains, are the important shallow fields, Graham, Fox, Walters, Robberson, Velma, Knox, Tussy, Tatums, and Sholem Alechem, discovered between 1917 and 1921. In 1937 deep production was found at Milroy, in 1935 at Fox, and in 1941 at Velma.

Prospecting will probably be for the Hunton and Simpson on the trend north-west from Cement.

Correlation of the Pennsylvanian with that of East Oklahoma or North Texas is very difficult. G. D. H.

1210.* Geological and Geophysical Profiles through the Eola Field, Louisiana. W. P. Jenny. *Oil Gas J.*, 11.9.41, **40** (18), 42.—It is known that large unconformities may

occur between the Wilcox and Cockfield on structures along the Sparta–Wilcox trend of Texas and Louisiana, and therefore it is unwise to appraise deeper structural possibilities from a few scattered normal or almost normal Cockfield wells.

A north–south section through the Eola field shows an almost continuous regional dip of 120 ft./ml. in the Cockfield, in spite of its overlying a faulted Wilcox structure with an uplift of 300 ft. There is only a slight suggestion of the Wilcox structure reflected in the Cockfield.

In the east–west profiles, the micromagnetic profile agrees well with the Wilcox structure, and the reflection profile gives a fair impression of the Wilcox structure, but indicates a closure of only 100 ft. The intricate fault pattern and possible lateral change in over-all velocities may explain the imperfect agreement. The Cockfield profile is a good indication of the Wilcox structure in spite of the unconformity.

Similar unconformities between the Wilcox and Cockfield are reported on other structures, and in addition to the local structural unconformities, there are probably large unconformities on regional structures in this belt. The large positive and negative regional magnetic trends observed in this belt may indicate anticlinal and synclinal regional trends in the Wilcox below a normal Cockfield. Such regional structures may in turn affect the seismic velocities and so influence the seismic interpretation. G. D. H.

1211.* Well Logs and Field Data of Active Oil Areas—North-eastern Texas and North-western Louisiana. Anon. *Oil Gas J.*, 25.9.41, **40** (20), 56B.—Within the area dealt with lies the East Texas Embayment, with a series of faults on the north and west, and the broad, flat Sabine uplift of North-west Louisiana on the east. At present the Eocene production is not high and the Upper Cretaceous is not of great importance. Woodbine production is limited to the East Texas Embayment. The first Woodbine pools were on the faulted western side of the East Texas Embayment, and the East Texas field occurs where the Woodbine is truncated against the Sabine uplift. Production has been found on a few structures recognized as deeply buried salt domes.

Early prospecting in the Lower Cretaceous was on the higher parts of the Sabine uplift, and Rodessa in 1935 demonstrated the value of the Lower Cretaceous.

Near Lisbon distillate production has been found in the Smackover lime below 10,000 ft. This test ended in Jurassic salt at 11,834 ft.

A map, set of well logs and a generalized stratigraphical column are included. G. D. H.

1212.* Ellenburger Structure Large in West Wichita County, Texas. R. M. Sanford. *Oil Gas J.*, 25.9.41, **40** (20), 70.—The K.M.A. deep field and the Electra deep field form one of the largest productive Ellenburger lime structures yet discovered. Most of the K.M.A. deep development has consisted of deepening old wells, and the same is true of Electra, where the old holes only require to be deepened by 900 ft. The area has three productive spots. K.M.A. produces from the Ellenburger at 4350–4400 ft., the deep production being in the south-western part of the old field. Sixty deep wells have proved 5000 acres.

In the Electra area two additional Ellenburger lime-producing spots have been found.

Only the K.M.A. Ellenburger high has been amply tested and found productive. The Ellenburger high just west of K.M.A., with 200 ft. of closure, has only one deep well, and that failed to make commercial production. Just north of Electra is a high with 150–175 ft. of closure, and this is at the top of the structure. It appears likely that there may be continuous deep production from K.M.A. to Electra. All the areas of closure are along the Electra Arch.

The Ellenburger lime is more prolific than the regular K.M.A. wells in that part of the field, and many wells here have initial potentials of over 1000 brl./day.

A stratum contour map of the Ellenburger is included. G. D. H.

1213.* Peak Drilling Activity Forces Illinois Production Upwards. H. F. Simons. *Oil Gas J.*, 9.10.41, **40** (22), 12.—September's oil output was the highest in Illinois since August 1940, when the Centralia and Salem Devonian development ended. The current production is more than 430,000 brl./day. During the first seven months

of 1941 the steady production averaged 339,000 brl./day. In September 380 tests were completed, forty-six being wildcats and thirteen of these discovered new fields or extended old ones.

Seventy-one new fields or extensions have been discovered this year, and those made between 1st July and 22nd September are tabulated with the pertinent data. The most important fields are Johnsonville and Woodlawn. The Hoodville–Dale–Rural Hill area seems likely to be one of small pools.

The coal domes in the southern part of the State may become important features. Tests on the tops of these were poor, but good production has been found around the edges and along the sides of the domes. The Dale–Hoodville area is near such a dome, and the Rural Hill field may be similarly situated. G. D. H.

1214.* Well Logs and Field Data of Active Oil Areas—South-west Texas. Anon. *Oil Gas J.*, 9.10.41, **40** (22), 52B.—The roughly triangular area bounded by the Rio Grande and the Gulf of Mexico on the west and east, and extending as far north as Corpus Christi, contains 200 oil- and gas-fields. The early search was for salt domes, of which two were found with only a small production. During the 1920's a number of shallow fields were found along the Mirando sand trend which yields oil mainly from the Jackson and in places from the Frio, Catahoula and Yegua. Typical of the better fields along this trend is the Government Wells–Loma Novia group, in which production is obtained from a number of eastward-dipping sands. Deeper drilling along this trend is establishing lower pays as possible sources, down to and including the Cook Mountain.

Below the Mirando pay a relatively thick series is locally productive, and has good possibilities. The Wilcox is believed to be more favourable than the Mount Selman.

The Benavides–Pettus trend includes a number of fields in which sands in the same general series as the Mirando sands produce down-dip where they form wedge edges. These sands are generally of Jackson and Cockfield age, producing at 4000–5000 ft. South of Duval County on this trend the overlying Frio and Vicksburg yield oil. The next trend lies in the Frio sands, which are a down-dip phase of the outcropping Catahoula. This series has provided the most prolific producing areas of South Texas. In the past year crude has been found down-dip from gas-distillate structures.

Along the coast is the most easterly producing trend, the Marginula.

A map, generalized stratigraphical column, and a series of well logs are included. G. D. H.

1215.* Dakota Lease Play Continues with Little Drilling. Anon. *Oil Gas J.*, 9.10.41, **40** (22), 89.—Although hundreds of thousands of acres have been leased in North and South Dakota, only one major drilling operation has been undertaken in this general area, and that lies in Montana, just over the North Dakota line. The well found oil-shows at 6700 and 8360 ft., and is expected to go to 10,000 ft. In western South Dakota there are likely drilling sites.

On the Two Top structure a well was abandoned at 1100 ft. after reporting gas, and a second well was junked. Two wells in the Black Hills of western South Dakota are reported to be shut down.

8,000,000 acres have been leased in North and South Dakota. G. D. H.

1216.* Wilcox Trend Play Maintains Mississippi Exploration. R. M. Sanford. *Oil Gas J.*, 16.10.41, **40** (23), 76.—The newest Wilcox discovery at Larto Lake, Louisiana, is only 40 ml. north-west of the centre of Wilkinson County, South-west Mississippi, an area where there has been much leasing recently. Some Mississippi wells have penetrated the upper few hundred feet of Wilcox, but most Mississippi wells stopped short of the Wilcox zone, which will be several thousand feet deeper than in the productive fields of the neighbouring part of Louisiana. North and east from Wilkinson County the Wilcox rises to depths comparable to those of the Louisiana area.

Several tests drilled on the Wilcox trend in South-west Mississippi have found favourable shows and outlined local structures. In Central Wilkinson County a well encountered promising shows in the lower Miocene at 4472–4479 and 4573–4579 ft. In the north-central part of the same county a well found shows in the Cockfield at 3905–3910 ft. Moody's Branch marl gave gas in the south-western part of Wilkinson County.

Apart from the south-western part, most of southern Mississippi is considered to contain a large subsurface salt basin. This embraces many interior domes and local structures. On the southern rim of the salt basin is the Wiggins ridge, on which wells have found shows of oil.

Mississippi's latest prospective oil discovery, the Cary field, is on the Sharkey platform, a structure consisting of Upper Cretaceous beds laid unconformably on uplifted and eroded Lower Cretaceous beds. The only well is giving 46 brl. of oil/day with 419 brl. of salt water from 3285 ft.

Mississippi's oil fields are Tinsley (61,777 brl./day), Pickens (357 brl./day) and the Cary well. G. D. H.

1217.* Johnsonville Pool Nears Limits after Rapid Development. H. E. David. *Oil Gas J.*, 16.10.41, **40** (23), 83.—The new Johnsonville pool of Central Wayne County has been largely responsible for the impressive rise in Illinois production during the past few months. Its daily average is 60,000 brl. from the McClosky. Since 15th July, nearly 100 wells have been completed with average initial productions of almost 2000 brl./day. The largest well gave 9300 brl./day. The depth of the McClosky is about 3040 ft. and the average pay thickness 18 ft. Some wells find four pay-breaks. The flowing life of the wells is short and the initial decline rapid.

Production covers nearly 4000 acres, with the north, north-west and south-east limits partly defined.

The Aux Vases sand has been proved capable of production in this field, several wells having reported saturation capable of giving 1000 brl. wells. No well has explored deeper horizons at Johnsonville. Shallow Benoist production seems possible. G. D. H.

1218.* Completions above 100 Daily First Time since 1937. Anon. *Oil Wkly*, 8.9.41, **103** (1), 49.—For the first eight months of this year completions were 1·8% below those for the corresponding period of last year. During August 2822 wells were completed.

A table gives the numbers of rigs in operation on 1st August and 1st September, 1941, and on 1st September, 1940, by States, with the state of activity on 1st September, 1941. A second table lists by States the total wells drilled during the first eight months of 1941 and their status, and also the wells drilled during August 1941. G. D. H.

1219.* Drilling Activity near High Established in 1937. Anon. *Oil Wkly*, 13.10.41, **103** (6), 34.—During September the number of completions per day was the highest so far this year, and averaged 102·6 wells per day, as compared with 82·8 per day for September last year, and 99 per day during July and August 1941. During the first nine months of 1941 the average weekly completions were 3·8% more numerous than for the same period of 1940.

Tables give by States and districts the total rigs in operation on 1st October, 1940, 1st September, 1941, and on 1st October, 1940; the details of the field activity on 1st October, 1941; the monthly completions for September 1940, August 1941, September 1941, and their initial oil production; the cumulative completions for the first nine months of 1940 and 1941; details of the completions in the first nine months of 1941 and the initial outputs of the wells. G. D. H.

1220.* Current Exploration and Leasing Activity in the Dakotas. Anon. *Petrol. Engr*, July 1941, **12** (11), 58.—Oil exploration in North and South Dakota is spreading after being confined mainly to the central sections of the States. Recently interest has been shown in Perkins, Brule, Charles Mix, Codington, Spink and Beadle Counties, and the Black Hills in South Dakota, and in Adams County, North Dakota. Leases are said to cover 7,500,000 acres. A well on the Cedar Creek anticline, Montana, near the Dakota boundary, has reached 6000 ft. The Minnelusa is to be tested near Rapid City, and this area is only a few miles east of the Osage field, Wyoming.

The most active leasing is in the central part of the Dakotas. G. D. H.

1221.* Shallow Wilcox Accelerates North Louisiana Development. M. M. Kornfeld. *Oil Wkly*, 15.9.41, **103** (2), 16.—The Olla field of La Salle Parish, Louisiana, discovered in 1940, was the first large producer of oil from sands below the top of the Eocene Wilcox group. Urania, 4 ml. to the west, has given 23,000,000 brl. of oil from the Cana River–Wilcox contact between 1925 and 1940. Late in 1940 the Nebo field opened up a second deeper Wilcox zone at 3350–3697 ft., 1300 ft. below the top of the Wilcox. Six oil- and three gas-fields have now been found in North Central Louisiana, at 2250–5124 ft. This up-dip Wilcox development is in an area previously condemned by dry holes in the Cockfield–Sparta–Upper Wilcox.

The Olla trend is a tongue-shaped "high" centred in La Salle Parish. It runs over 100 ml. slightly west of north. The feature is shown by magnetic maps and by the isopachyte maps of the Cockfield and the Wilcox. Along the crest are the Urania–Tullos–Georgetown (Upper Wilcox), White Sulphur Springs (Cockfield), Olla (Middle Wilcox), Zenora, Little Creek, Trout Creek, Nebo, Hemphill, Walters, and Lake Larto (all in Middle Wilcox) oil-fields. The gas areas are Big West-Lowe, Trout Creek, and Summerville (all Middle Wilcox). Production ranges 600–1635 ft. below the top of the Wilcox.

In this area there are three major sand zones below the top of the up-dip Wilcox, and each is divided. Individual sand correlation from field to field is not attempted because of the irregular nature of deposition and distribution.

The discovery well data are tabulated, and a map and series of electrical logs and a mud analysis log are appended. G. D. H.

Geophysics and Geochemistry.

1222.* Core Drill and Seismograph Greater Discovery Factors in Kansas Oil Development. J. A. Kornfeld. *Oil Wkly*, 28.7.41, **102** (8), 32.—An increasing proportion of oil discoveries in western Kansas are attributable to the core-drill and reflection seismograph, whilst there has been a decrease in the effectiveness of subsurface methods.

Exploratory work in western Kansas is complicated by the low relief of the buried erosional features on the Central Kansas uplift, the effects of post-Ordovician and post-Mississippian erosion, the blanketing by the Pennsylvanian, the numerous unconformities, overlaps, and stratigraphic variations.

The core-drill was most effective in 1935, surface methods were most prolific in 1936, and the reflection seismograph, alone or in conjunction with other methods, gave the best results in 1937. It is too early to assess the value of geochemical methods in this region.

Early in July a major producing area was discovered 15 ml. north-west of Lakin, the structure having been outlined by the reflection seismograph and core-drill. The core-drill holes are taken to 1500–2000 ft., and are electrically logged and used for geophone tests for detecting and analysing abnormal structural and stratigraphical conditions. Core-drilling permits the determination of the attitude of the Permian beneath the Cretaceous, and the form of the Fort Riley limestone is a clue to structural conditions beneath the pre-Pennsylvanian unconformity.

The Cimarron anhydrite has proved a satisfactory reflecting horizon in some seismic work, but deeper horizons are required. In continuous profiling the divergence of the reflection intervals may be an indication of stratigraphic traps or pinch-outs on the flanks of the Central Kansas uplift.

Tables show the percentages of discoveries attributable to the various methods in 1939 and 1940, and the numbers of discoveries by core-drilling, the seismograph, and surface geology each year since 1920. The use of the core-drill and reflection seismograph in this area is discussed in some detail. G. D. H.

1223.* Geological Interpretation of Regional Magnetic Anomalies in Central and Southern United States. W. P. Jenny. *Oil Wkly*, 22.9.41, **103** (3), 17.—During recent years it has been shown that the majority of magnetic anomalies in areas of thick sedimentation are due to the magnetic content of certain sedimentary horizons. Certain anomalies are due to thickening of relatively shallow magnetic horizons. The anomalies may be due to the sediments, to the basement, or to both. Thinning

of magnetic sediments over an anticline may cause the magnetic highs to be in the synclines.

In the Amarillo–Wichita–Arbuckle mountain systems, the magnetic picture corresponds closely with the topography of the basement igneous rocks. The magnetic vectors in the Appalachian area are generally lined up in a north-westerly direction, and are largely negative. West of the Appalachians is a series of positive anomalies pointing to an uplift of the basement along the western boundary of the mountains.

In the Gulf Coast area the basement is very deep, and the main magnetic anomalies are due to the sediments. Many of the magnetic highs are due to the thickening of magnetic beds in basins, but farther inland deep-seated anticlinal axes may be connected with magnetic highs.

The magnetic maximum in the centre of the Illinois basin is probably due to thickening of the Pennsylvanian and Mississippian beds.

The occurrence of thick, non-magnetic Ordovician limestones is probably the cause of the negative anomalies in the central area of the Ozarks and the Cincinnati dome. The northern end of the La Salle anticline is marked by a positive anomaly due to approach of the basement to the surface, and the southern end shows a negative anomaly due to thinning of magnetic shales on the anticlinal axis. Uplifts of the basement in Michigan give positive anomalies.

Basement trends, as revealed by magnetic anomalies, may be a key to the location of stratigraphic traps.

A map shows the regional magnetic anomalies in sixteen States of Central and Southern U.S.A. G. D. H.

Drilling.

1224.* Vermiculite Finding Increasing Application in Oil Industry. T. P. Sanders. *Oil Gas J.*, 31.7.41, **40** (12), 155.—Vermiculite is a member of the mica family which contains water of crystallization, together with free water held as microscopic inclusions within the laminated structure. On sudden heating the water is changed to steam, causing each particle to puff up almost instantaneously to about fifteen times its original size.

Since the expanded mineral will resist temperatures up to 2450° F. without fusing and because of its myriads of tiny dead air cells, it is an ideal insulator against heat loss. Its use on engine mufflers and on engine-room walls as a sound-absorbing material is well established, and exhaustive tests have now shown it to be of great value as a drilling mud.

It is mined near Libby, Mont., and is expanded by dropping through a special furnace at 2000° F. This product can then be used in a granular form as an insulator, or cast into bricks or other forms using a small amount of binder. In any form it is fireproof, rotproof, and entirely unreactive. An entire refinery in California has been insulated with vermiculite, and its use in brick form is being developed for the inside of cracking units. Oil tankers liable to bombing attacks use a covering of this mineral for decks and fire walls. As a drilling mud it is supposed to have ideal qualities for sealing off porous formations and is capable of remaining indefinitely suspended in water. C. L. G.

1225.* Use of Acid-Soluble Cement in Cementing Oil and Gas Wells. R. L. Tracey. *Oil Gas J.*, 25.9.41, **40** (20), 56.—In connection with the use of acid-soluble cement the acid jet-gun is described. If a removable squeeze tool is used, tools are not required for drilling out the cement left in the casing. The acid jet-gun, with jets directed at a slight angle downward, will remove the cement quite rapidly. This gun can be run on a measuring line (a safe procedure when inhibitors are used in the acid) to a position in a seating nipple at the bottom of the tubing. When a desired vertical distance has been drilled, the gun is quickly pulled out of the hole and the downward-directed jets are replaced by horizontally directed jets. The treatment then proceeds as in the case described above, after the cement has been drilled out with tools to a suitable level.

After discussing the various uses to which acid-soluble cement can be put, it is concluded that: (i) Acid-soluble cements, as shown by both laboratory and field data, possess the desirable properties of oil-well cements; in addition, they are more durable in brines and more easily removed from wells by acidizing, thus making possible

improved cement practices. (2) When acid-soluble cement is used, the cement can be acid-treated and removed much more completely than when regular cement is used. (3) Acid-soluble cement has extra setting abilities in oil zones and when intimately mixed with oil or salt water. (4) The length of time which the acid-soluble cement has been in a well apparently has no detrimental effect on the ease with which the cement can be removed with acid. (5) Treated bentonitic material in quantities up to 3% can be used with the acid-soluble cement without apparent effect on its ability to be removed by acid. (6) Acid-soluble cement can be squeezed against adjoining oil, water, and gas formations indiscriminately. Later it can be removed selectively from behind perforations in casing or liner, or from below the casing seat by jetting in an horizontal plane with the acid jet-gun. (7) The results of several acid-soluble cement squeeze jobs are tabulated.

In removing the cement, volumes of acid varying from 500 to 5000 gal. were used, by both the jet-gun and tubing methods. A comparison of the production figures before the squeeze job and after acidizing shows that in every case the water production was greatly decreased, and that the oil was substantially increased in three of the wells. A. H. N.

1226.* Applying Formation Logging Through Mud Analysis. H. F. Simons. *Oil Gas J.*, 2.10.41, **40** (21), 33.—The instruments used consist of a gas detector, a salt-water detector, an ultra-violet light for detecting oil, a rate-of-penetration indicator, and instrumental means for determining the amount of fluid moving in and out of the hole. The depth, rate of penetration, gas, and fluid lag are self-recording. This latter instrument enables fluid coming out of the hole to be correlated with the depth at which it emerged from the bit and picked up part of the fluids in the formation being drilled. Using the data obtained from these instruments it is possible to tell the interface between two formations, the content of the formations, the oil-gas interface, and often the relative porosity and permeability in a producing formation.

The mud-logging procedure has two major applications: the location of possible pay zones with the determination of their economic importance as encountered, and the obtaining of information which will aid the operator in selecting the proper completion procedure. Where several oil- or gas-bearing horizons are encountered, the best zone can be selected.

The information obtained is logged in a manner similar to other methods of identifying formations, and the results can be compared directly with them, although the data are obtained in an entirely different manner.

A typical log is given, and the significance of various points of importance is explained.

Mud logging has been widely used in practically every area in which the rotary method is practicable, including East, West, and North Central Texas, the Gulf Coast of Louisiana and Texas, Northern Louisiana, Mississippi, New Mexico, Oklahoma, California, and Kansas. Its principal use in Proven fields has been the location of upper oil- or gas-bearing strata and the obtaining of information necessary to a proper completion. This means that only certain sections of the hole are logged. Such a record shows proper perforation points, gas-oil ratio to be expected, and best place to set a packer, shoot, etc. Unnecessary coring of possible producing horizons is also eliminated. It also gives a permanent record on which to base remedial work.

On wildcats it provides a safe means of eliminating unnecessary cores, which are costly and in some cases hazardous. In one case a well was drilled to 10,000 ft. with only five cores being taken in three different horizons, but the drilling operation was stopped about fifty times to determine whether to core a sand or not. Previously the operator would have ordered the taking of many of these cores to make sure he did not pass up an oil sand.

In areas where hard formations are encountered the procedure is to drill 3 or 4 ft. into a zone after a definite break has been noted on the rate of penetration recorder. Circulation is continued until the mud which was around the bit has been brought to the surface and analysed. From the intensity of the showings of oil or gas a decision can be reached whether to core or to drill ahead.

The accuracy of the various instruments used is discussed. A. H. N.

1227.* Triplex Steam Pumps Gaining Favour on California Rigs. T. P. Sanders. *Oil Gas J.*, 2.10.41, **40** (21), 50–51.—Characteristics of the new triplex pumps have

been thoroughly established, but are new in rotary drilling, and their use on deep tests in two different fields will furnish additional data for evaluating this departure from the long-established duplex design. Two considerations were primarily responsible for the triplex mud pump. One was the possibility of making a pump which by itself would have sufficient capacity for deep drilling, thereby rendering it unnecessary to compound two pumps. The other consideration was the realization that the overlapping of strokes would greatly reduce pounding and would produce a more constant pressure on the discharge manifold.

An entirely new design for the steam-valve mechanism made it possible to operate on a much shorter cushion in the steam cylinders, thereby reducing the necessary cylinder length and also the steam requirement. The triplex is an 18 × 7 × 20-in. pump, but its overall length is less than that of regular pumps having a 20-in. stroke. Overall length including skids is 12 ft. 7 in.; width is 7 ft. 11 in., and its height, including the air chamber, is 8 ft. 9 in. Its weight is 31,500 lb. It can be moved on the highways without dismantling and without a special permit.

A new feature is seen in the construction of the mud end of the pump. Each cylinder is a separate steel casting, and they are all interchangeable. A serious accident might call for a new cylinder casting but not for an entire new mud-end. The cast steel manifolds, together with the three cylinder castings, make five separate castings in the mud end.

Installation of the liners is unique. A large-diameter set-screw extending through the centre of the cylinder head is used to tighten the liner in the cylinder casting without removing the head. Within the cylinder is the line-spacer, which has an external rim for centring the liner. The spacer-ring butts against the end of the liner, and is held in place by means of the large setscrew previously mentioned. Friction is reduced by means of a roller thrust-bearing, so that when the adjusting screw is turned down, the operator can easily tell when there is a metal-to-metal contact at both ends of the liner. This arrangement not only makes it possible to ascertain that the liner is tight at all times, but also makes for convenience in removing and exchanging liners. A packing-ring prevents leakage around the adjusting screws.

A. H. N.

1223.* Slim-Hole Drilling Develops Changes in Technique. H. F. Simons. *Oil Gas J.*, 23.10.41, **40** (24), 32.—Comparing slim-hole operations with big-hole drilling is difficult because of the large number of factors which must be evaluated. As the slim-hole rigs being discussed are company operated, they have a definite schedule laid out, and a rig never has to wait on a location, but moves directly to it as soon as the pay-string of pipe is set. This is in contrast to the contract rig, which is generally torn down and temporarily racked while waiting for a location. The divergence in the operation does not end there, but extends to the overhead and investment charges, which are substantially higher for the contractor. A general comparison of the operating end can be and has been made by many of the companies, and shows that when competently operated the slim-hole rigs have no disadvantage while drilling and have a definite advantage in moving, operating, labour, bit, and casing costs.

Two of the rigs used in the East Cromwell field are equipped with 84-ft. derricks and two with 58-ft. derricks. The latter can be raised in 5 min. after the unit has arrived at the location, and the blocks remain strung while moving. It takes approximately 1 hr. to bolt the top half of the 84-ft. derrick to the bottom portion, which is attached to the raising mechanism and which remains on the truck, and then raise the derrick. The blocks have to be strung each time. The taller derricks more than justify the additional rigging-up time as at 3500 ft. it takes only 2¼ hr. to make a trip, whilst on the shorter masts trips require 3¼ hr. As it requires from twelve to fifteen bits to make the hole, the operating time on each well is reduced by 7–10 hr. by using the taller derricks. Later model rigs of the same type can carry the 84-ft. derricks in the field and require only a few minutes longer to raise than the single masts.

Details are given of the engines, lines, mud system, drilling, and fishing operations used. Drill-stem tests are frequently resorted to and are carried out as easily and with as much certainty as on the larger holes. The coring programme varies with the locality, but cores are frequently taken on the slim-hole rigs and over a period of time the recovery has averaged about 80%. Electric logging is used extensively

to determine the pay horizons in the small holes, and the operation is conducted without difficulty. The use of mud analysis as a means of logging in wildcats and in lime country produces a more immediate reading, as the smaller holes ensure quicker return of the drilling fluid.

In short, slim-hole drilling presents some changes in operation, many advantages, and practically no disadvantages. A. H. N.

1229.* Shell Using Steam-Operated Pipe-Tongs at California Rig. T. P. Sanders, *Oil Gas J.*, 23.10.41, **40** (24), 48.—The drilling power-tong is an adaptation from the previously designed pneumatic McFadyen geared tubing tong. The chief reason for its development was to avoid the accident hazard presented by the spinning line and cathead. Secondary reasons were reductions of round-trip time and uniform make-up for all joints of the drill-string.

Unlike the pneumatic tubing tong, the steam drill-string tong is only used while the pipe is being run into the hole, as the pipe is unscrewed by spinning out with the rotary table when coming out of the hole. It now appears improbable that a portable power tong will even be suitable for breaking down drill-pipe because of the high torque required for breakout.

In the power tong the self-engaging jaws are mounted within a large circular main gear, which has an open throat to permit insertion over the pipe. This main gear is operated by two drive-gears so placed that one will always be engaged while the other is opposite the throat or cutaway portion of the main gear. The two drive-gears are operated by a fourth gear, and this in turn is connected to the crankshaft of a four-cylinder radial engine of a type commonly used in mines to drive small pumps.

Built for compressed air, high-pressure gas, or any other expansive medium, the tong engine is operated by steam at the Shell rig. A regulator on the supply line reduced the steam pressure to a constant 120 lb. The tong is counterbalanced in the derrick like regular tongs, and a wire " backup " line is used to keep it stationary while it is applying torque. A. H. N.

1230.* Portable Drilling Unit Used as Moving Tool. Anon. *Oil Wkly*, 13.10.41, **103** (6), 36.—A light-weight, truck-mounted portable drilling and well-servicing unit has been pressed into moving service by a California operator. With the telescoping derrick extended the mast serves as a long boom, and with it compressed it affords straight lift with high capacity. When not required for servicing the unit is not allowed to stand idle, but assists in moving large, 8000-ft. drilling rigs with 122-ft. derrick mounted on skids and substructure. A. H. N.

1231.* Mud Analysis as a Basis for Well Logging. H. L. Flood. *Petrol. Engr*, September 1941, **12** (13), 21–26.—A well is assumed to be drilled with a 10-in. bit at a depth of 5000 ft. at a rate of 10 ft./hr., and 800 brl. of mud is circulated/hr. The volume of the material cut, pulverized, and removed from the hole would be 9425 cu. in., the equivalent of 41 gal., or nearly 1 brl./hr., representing 1 part in 800 or 0·125% of the fluid circulated. If the porosity of the formation is, say, 30%, and the pores are filled with fluid, approximately one-third of a barrel/hr. of formation fluid will be added to the circulated fluid—a ratio of approximately 1 part in 2400.

If the pore space were filled with gas at a pressure of, say, 200 atmospheres (3000 lb./sq. in.), gas from the cuttings would enter the mud at the rate of 330 cu. ft./hr. These figures give one an idea of the volume of formation fluids (oil, gas, and water) that are in the mud-returns. Instruments used in mud-logging are sensitive enough to detect even minute quantities of oil or gas; gas volumes as small as 1 cu. in./hr. can be detected in the drilling mud. It is important to note that the weight of the mud column prevents the inflow of fluids from the wall of the hole, hence formation fluid (oil, gas, or water) returns is that from the drill cuttings only.

In addition to detecting the presence of oil or gas, it is obviously important to determine accurately the depth at which the indications of oil and gas are observed. This is done by adjusting for the " lag," or the time required for the fluid to reach the surface.

Thus, the mud-logging equipment employed consists of: (1) equipment for the detection and measurement of oil and gas (and also salt water) in the mud returns, and (2) equipment for correlating the showings of oil and gas with the depths.

The equipment housed in a trailer in one particular form of apparatus, and which is used for logging mud is described, together with the procedure involved in the various measurements. Typical logs obtained in West Texas are included.

An interesting part of the apparatus is the depth-meter. This meter registers on two counters, showing depth of the hole and the distance bit is off bottom, respectively. The latter counter registers only when a trip is made or the bit is raised off bottom while circulating. This instrument is entirely automatic in operation. It has two selsyn motors, one of which is actuated by the movement of the travelling block in the rig. Movement of this motor energizes a companion motor behind the instrument panel. Downward movement of the bit increases the reading of the depth-meter. When the movement of the bit is upward the depth-meter remains stationary and the counter showing the distance off bottom begins operating.

Although the primary purpose of the depth-meter is to apprise the logging operator of drilling progress, it serves as a check against the driller's tally of depth. It also shows the rate of penetration by recording in ft./hr. the time required to drill the formations. A. H. N.

1232.* **Mathematical Analysis of Whipstock Setting.** A. W. McCray. *Petrol. Engr*, September 1941, **12** (13), 63.—The correct solution of a directional or objective drilling problem, from an engineering viewpoint, must be based on these principles: (1) The well must reach the desired objective; (2) for economical drilling, the least possible number of whipstock settings must be used; (3) furthermore, the amount of curvature in the well bore must be kept at a minimum in order to obtain maximum economy and ease of operation of the well during production. The last two principles go hand in hand; with any given whipstock angle, satisfying the conditions of one satisfies the conditions of the other.

Most wells are drilled to reach a definite point, whether it be under the derrick floor or a point having several hundred feet horizontal displacement from the top of the hole. In the problem considered here, a well has been drilled part way down and a survey of the hole has been made. Information is then available giving the location of the bottom of the hole drilled (or some take-off point above bottom may be selected) and the horizontal direction and inclination from the vertical at that point will also be given by the survey. Knowing this, and the position of the objective point, the problem consists of calculating the required whipstock settings.

After setting down the principles of solid geometry on which the solution of the problems of whipstock setting are based, 3 figures are given. A vector solution is shown in Fig. 1 that gives the theoretically correct direction in which to point a whipstock in order most economically to reach a definite objective point. This solution should be repeated for each setting in order automatically to correct for deviations from the ideal deflection that will occur in actual practice. Fig. 2 is an alignment chart that can be used to give the direction a new section of hole should assume, and Fig. 3 is an alignment chart giving the fractional length of a section of drilled hole that will appear on a horizontal map. The two alignment charts can be used for plotting possible future courses of the hole. In this manner an economic study can be made showing the best point to take-off from the original course of a well in order to reach some new objective. A. H. N.

1233.* **Electric Power Used to Drill World's Second Deepest Well.** C. F. Forsberg and W. A. Sawdon. *Petrol. Engr*, September 1941, **12** (13), 117.—Although drilled with equipment not designed for drilling to the depths penetrated, Honolulu Oil Corporation experienced little trouble in reaching 14,622 ft. in a well recently drilled with electric power at Buena Vista Hills near Taft, California. This well, designated as 25-P, is the deepest electrically-drilled well in the world, and came within 382 ft. of reaching the record of the only other well that is deeper. No particular depth was contemplated when the well was begun on 1st June, 1940, as the objective was a thorough test of the oil and gas possibilities of the structure.

The rig was installed in a 136-ft. derrick, and 1¼-in. wire line was used for the deeper hoisting. The draw-works was driven by two 8-pole, 440-volt, 125-h.p. variable-speed motors direct-connected through flexible couplings to a twin motor reduction gear. The motors and reduction gear were mounted on one base as a unit, and

powered the draw-works through a chain drive from the reduction gear. The motors were operated with oil-immersed magnetic controls through a small master switch so arranged that the two motors always operated on similar points of resistance, and thus divided the load equally. Either one or both motors could be used for hoisting. This provided for uninterrupted operation in case trouble developed with one motor or its control, as a single motor run at lower rates of speed could usually be employed for hoisting. This feature was used to advantage several times during the drilling of the well.

The controls for the draw-works motors were installed, in a portable house and permanently wired together. This equipment can be moved from one location to another after the drilling of a well is completed; when wiring a rig it necessitates only the running of the cables from the motors to the terminals at the portable control house and then making connections. This reduces wiring to a minimum and saves considerable time when rigging-up.

The drilling operations and mud control are described. It now appears that, with equipment of proper size, electrical power can be used to drill deep wells such as this with economy, with minimum trouble from the power end, and with results as satisfactory as can be obtained with any other form of power.

The operation of the two mud-pumps was reasonably satisfactory, but better performance could be obtained with modern control that permits stalling of the motors over an appreciable period. Better operation in paralleling the pumps would also have been possible with the new types of control now available.

Modern deep-hole drilling demands speed, and in order to meet this requirement it would seem that a 300-h.p. motor on the rotary machine and two 300-h.p. motors on the draw-works, with all necessary apparatus to go with them, would be desirable. Large mud-pumps driven by motors of proper size would also be required, and would eliminate the overloads that were necessary to drill this well. Features of the electric motor that must always be kept in mind are the high pull-out torque usually built into the motor and the capability of the motor to stand excessive overload for a time. These features are naturally dependent on the design, but the usual type of variable-speed motor selected for this work has a pull-out torque of approximately 400%, which means that it can do a very considerable job in an emergency. A. H. N.

1234.* Water Used to Drill-in Lime Wells in West Texas–New Mexico Area. H. L. Flood. *Petrol. Engr*, September 1941, **12** (13), 138.—One town-site well recently drilled was completed in 15 days, including the time required for setting casing. Although the well itself is relatively unimportant, being only a routine operation, the equipment used in its drilling is one of the newest rigs in use in the area and is an example of the lightweight, streamlined assemblies now gaining in popularity for drilling to 5000-ft. depths.

After 175 ft. of 9⅝-in. casing had been set and cemented, the well was drilled to a depth of 4201 ft., using fifteen 8¼-in. rock bits. The 5½-in. oil string was set at a depth of 4128 ft. and cemented with 518 sacks of cement. Approximately 11 lb. mud was used during the drilling. Weight of 8 to 10 points is usually carried on the bit by drillers in this area.

While waiting for the oil string cement to set, the drill pipe was laid down and preparations made for drilling-in the well using tubing as drill-pipe. Clear water was circulated while the well was drilled-in. Every effort is exercised in completing wells in the Permian limestone sections to avoid plugging the formation with mud or any material that might reduce the flowing capacity of the well. Clear water, having less weight than mud, will impose less pressure against the formation.

A 4¾-in. rock bit and a 2-ft. drill collar sub were used on the tubing drill string and a 3-in. kelly was used to rotate the pipe while drilling-in. Approximately 3 points of weight were carried on the tubing.

The rig used is described.

1235.* Control of Filtration Characteristics of Salt-water Muds. G. R. Gray, J. L. Foster, and T. S. Chapman. *Petrol. Tech.*, September 1941, A.I.M.M.E. Tech. Pub. No. 1351, 1–9.—When strata containing soluble salts are encountered in the course of drilling, the salts are incorporated in the mud, flocculating the clay solids and increas-

ing tremendously the water loss by filtration. Laboratory examination was made of the effects on filtration characteristics and viscosity of salt-water muds of the addition of natural gums (tragacanth, karaya, ghatti), seaweed (Irish moss), or gelatinized starch. In each case the volume of filtrate in 30 min. decreased as the amount of gum, starch, or seaweed was increased (1% of gum, starch, or seaweed gave a very small amount of filtrate in all cases). Except for ghatti gum and starch, the viscosity increased continuously with the amount of gum, etc.

Field tests were made with gums and gelatinized starch, and in addition to filtration being reduced, there was other evidence of improvement in wall-building properties in the freedom from stuck drill-pipe and ease of running casing to bottom in holes drilled with treated muds.

The average cost of muds for fifty wells drilled with starch-treated muds was slightly less than for seventeen wells drilled with untreated muds. G. D. H.

1236.* **Comparison of Marsh-funnel and Stormer Viscosities of Drilling Muds.** J. E. Owen. *Petrol. Tech.*, September 1941, A.I.M.M.E. Tech. Pub. No. 1373, 1–9.—The Marsh funnel and Stormer viscometers were calibrated by means of a series of liquids in which the density was 7·1, 9·3, and 11·0 lb./gal., and the viscosities 2·5–55 centipoises. It was found that the higher the density the greater the weight needed to give a certain rate of rotation of the Stormer viscometer. Nineteen of the drilling muds were adjusted to a Marsh-funnel efflux time of approximately 40 sec., and divided into three groups according to the density, whilst seven were adjusted to an efflux time of about 32 sec. All the muds were thoroughly stirred for 15 min. before testing. A linear relationship was found to hold between the logarithms of the Stormer cylinder test speed and the resulting apparent viscosity. In the case of the muds adjusted to a Marsh efflux time of 40 sec., the various curves in each of the three density groups intersected at about the same point, and the viscosity corresponding to this point was approximately that of the muds as determined by the Marsh-funnel calibration. The inference is that Marsh-funnel viscosities and Stormer values would be about equal at cylinder speeds of 1000–1200 r.p.m. Thus it is concluded that Marsh-funnel viscosity measurements are expressible in absolute units that may be correlated with Stormer viscosity measurements, provided the latter are made at 1000–1200 r.p.m. or extrapolation is made to these speeds, since it is difficult to make measurements at such high speeds.

The slope of the log-viscosity–log-r.p.m. curves is seemingly a measure of the initial shear strength of the mud. G. D. H.

1237. **Patents on Drilling.** D. Scaramucci. U.S.P. 2,253,536, 26.8.41. Appl. 29.6.39. Apparatus for cementing wells fitted with a measuring line and weights.

D. Scaramucci. U.S.P. 2,253,537, 26.8.41. Appl. 29.6.39. Apparatus for cementing wells with a measuring line using a pair of electrical conductors.

F. L. Darling. U.S.P. 2,253,691, 26.8.41. Appl. 6.11.39. Hose clamp.

H. W. Schuetz. U.S.P. 2,253,729, 26.8.41. Appl. 31.10.40. Thread protector for pipes.

L. B. Smith. U.S.P. 2,253,735, 26.8.41. Appl. 6.3.39. Method of making drill-jars for oil-wells.

R. B. Gaunt. U.S.P. 2,253,776, 26.8.41. Appl. 7.11.38. Deep-well apparatus comprising packing elements.

A. R. Maier and J. M. Shimer. U.S.P. 2,254,183, 26.8.41. Appl. 12.9.40. Table-seal for well-drilling rotaries.

D. Scaramucci. U.S.P. 2,254,246, 2.9.41. Appl. 18.8.39. Apparatus for cementing wells with two cementing plugs.

R. Brinneman. U.S.P. 2,254,563, 2.9.41. Appl. 27.4.39. Brake apparatus for oil-well pulling equipment. A. H. N.

Production.

1238.* Gas-gathering and Discharge Systems—Louden Pool Repressurin J. R. Randolph. *Oil Gas J.*, 25.9.41, **40** (20), 46. *Paper Presented before . . rican Petroleum Institute.*—Originally designed on the basis of engineering and geological estimates of future gas potentials and pool extent, the gathering system is now being further extended to serve a total of 173 leases from which some 19,000,000 cu. ft. of gas is produced daily. Seventy-one miles of welded pipe-line ranging in size from 2 in. to 16 in. are required to carry this gas from lease-tank batteries to the two compression plants, which are capable of a daily throughput of 17,000,000 cu. ft. Casing-head gas content ranges from 4 gal./1000 cu. ft. in richer areas to 0·6 gal./1000 cu. ft. in gas-cap regions, with the average falling at about 2·14 gal./1000 cu. ft.

Gas and oil from producing wells flow through a common flow-line into the lease separator or tank battery. Each separator is maintained under pressure by two regulators, one on the gathering system line and one on the vent-line. The latter regulator is set to open at a slightly higher pressure than the former, in order that separator gas will escape at the vent only when the flow is so great that the gathering line cannot handle the total volume. A second regulator is placed immediately down-stream from the pressure-actuated lease regulator. These vacuum-operated regulators, set only on leases which produce excessively dry gas, are adjusted to open when the gathering-line vacuum exceeds 5 in. of mercury. In this way the field gas of lowest gasoline content is vented until the supply to the plants falls and causes a vacuum on the lines, at which time the various vacuum-actuated regulators open and admit the lower gasoline content gas into the lines to maintain the supply to the plants.

When wells are tested for oil potential, or when no separator is needed at the battery, oil and gas flow is routed directly into the tank battery. Tank thief-hatches hold 8 oz. pressure on the welded steel tanks, causing gas to leave through the 3-in. overhead vent-line. Escape of this gas at the vent-line riser is prevented by a stack-valve set to open at a pressure slightly lower than that held by the tank hatches. A regulator on this line is set to open at approximately 10 oz. pressure to admit gas from the tank battery into the gathering lines. The orifice meter measures all gas entering the system from the lease.

Details of the system are given and illustrated. A. H. N.

1239.* Completion Methods Employed in Wabash Valley Area. F. C. Ploeger and J. R. Vaughan. *Oil Gas J.*, 25.9.41, **40** (20), 52. *Paper Presented before American Petroleum Institute.*—In drilling wells in this area it is not unusual to encounter as many as five possible producing horizons, consisting of McClosky lime, Aux Vases, Benoist, Cypress, and Tar Springs. When this condition is encountered, attempts have been made to produce two or more of these formations in the same oil-string. This has been done by the use of removable casing of several kinds, the most common being an aluminium alloy. This can be removed by a wall-scraping tool or by shooting. A magnesium-alloy pipe has also been used to place opposite an upper producing horizon which can be removed by a wall-scraper, by shooting, or by the use of acid. Because of the inability to obtain aluminium pipe, a low-carbon light-steel casing has been substituted. This has been effectively removed by wall scraping.

Aluminium alloy has been given preference due to its resistance to corrosion and because the properties of this pipe more nearly approach the requirements of the operator, relative to the selection of steel casing. It was found that aluminium alloy pipe is not affected by corrosion by chemical action and can be left intact in the oil-string until such time as it is desired to remove it.

The low mechanical properties of alloy and the low-carbon casing necessitate much care in handling and running. To obviate any possibility of damaging the joints in making up the threads, chain-tongs are used, being placed at least 12 in. from the end. Power-tongs should never be used.

In many cases it was not possible to secure drillable pipe, so regular steel casing was set through the upper pays. In doing this, the couplings were placed above and below the pay-zone, which would eliminate ripping or shooting a coupling when opening. The method of reaming has proved very successful. A regular blade will cut out the alloy pipe, whilst a tool-steel blade is required to cut out the low-carbon

pipe. The latter has been replaced by a regular blade having a tool-steel insert [illegible] cutting 60 ft. The low-carbon pipe will ream out at a rate of from 4 to [illegible] which is slightly faster than the rate of removing alloy casing. Other methods are described.

Where the operator desires to produce two or more pays simultaneously in the same string, several methods have been practised in opening the upper zones. A great number of wells have been completed by first shooting the lower horizon with nitroglycerine and, after testing same, gun-perforating the upper sands. As a general rule the increase in production after opening the upper pays was negligible; it often rose at the time of shooting, but rapidly declined to normal. Such results may be credited to the low permeability of the sand. The use of the gun perforator has been very effective in one area when opening the Waltersburg sand. One well typical of the area was swabbing 141 brl./day from a lower pay, and after shooting with nine ½-in. bullets/ft. in the Waltersburg sand it swabbed 216 brl./day.

Methods of completion as practised in this area at present lead to the conclusion that: (1) 7-in. casing for the oil-string is preferred because of the possibility of deeper production and the need for heavy shooting; (2) producing one zone at a time and beginning from lowest producing level would be the most economical were such a plan accepted by all operators in any area, upper pays to be produced at a latter date by plug-back jobs. A. H. N.

1240.* Pressure-maintenance Project Conserves Reservoir Energy. N. Williams. *Oil Gas J.*, 2.10.41, **40** (21), 30–31.—In the reservoir under discussion, located in South-west Texas, approximately 2,500,000 cu. ft. of gas has been returned to the producing horizon. In addition to the conservation of this gas, bottom-hole pressure of the sand has been stabilized, insuring prolonged flowing life for the producing wells and greater ultimate recoveries than could otherwise be expected. Nearly 1,000,000 brl. of oil has been withdrawn from the reservoir since pressure maintenance was started.

Involved in the project is the upper first Government Wells sand, the field's principal producing horizon, which, in its oil phase, lies at a depth around 3400 ft. This sand has a comparatively large, pronounced gas-cap, and, by the return of all produced gas to this horizon, it is hoped to preserve the pressure as nearly as possible to its original value. First bottom-hole pressure readings were made in 1937, at which time, with development of the sand in its early stages, the pressure was approximately 1300 lb. Before the pressure-maintenance operations were started in March 1940 the reservoir pressure had declined to about 1200 lb., but since then it has been held practically constant.

The structure is indicated to be a domal-shaped anticline with sands overlying and extending down the sides in more or less symmetrical contours. The oil-productive area of the upper first Government wells sand is circling the structure in a comparatively narrow strip, about three to four 700-ft. locations wide, roughly skirting the outer productive limits of the shallower sands.

Sand thickness averages 50 ft. Gas-oil contact has been found to be at a subsea depth of 2744 ft., with the water level at a subsea depth of approximately 2800 ft., leaving an oil column of approximately 56 ft. Through preservation of the gas-cap and controlled withdrawals it is hoped to maintain a uniform rise in the water-level to obtain the most effective utilization of the water-head in efficient recovery of the oil. Surface elevation of the field ranges from 550 to 600 ft.

To date forty-seven oil-wells have been completed in the upper first Government Wells sand. One rig is being kept running in a steady systematic development programme. There are fifteen producing wells in the various other sands. At present only the upper first Government Wells sand is being developed, most of the shallower wells having been drilled prior to the opening of this sand. So far the development has extended only around the south half of the structure. The spacing programme, based on locations 707 ft. apart at 1000 ft. intervals diagonally, allows an average well density of one well to 11·4 acres.

The plant used is described. A. H. N.

1241.* East Texas Salt-water Injection Plants Vary Widely in Design. D. H. Stormont. *Oil Gas J.*, 9.10.41, **40** (22), 34–35.—Injection of salt water to sands below the oil-

pay in the East Texas field has passed the 60,000-brl. daily mark. Furthermore, new plants under construction are expected to raise the daily total to more than 80,000 brl. by the end of this year. The plants used for treating this large volume of water prior to its injection vary widely in design and capacity. Practically all, though, are based on the same fundamental principles of thorough aeration and adequate settling time followed by filtration.

In bringing formation waters to the surface their equilibrium is disturbed by the change in temperature and pressure, contact with foreign materials, and exposure to air. In East Texas the principal task is to cause the iron in the water to change from the ferrous state into ferric compounds, so that it drops out as an insoluble precipitate and can be removed by decantation and filtration; also to permit any dissolved gases to escape. By allowing adequate aeration followed by sufficient settling time, most operators have been achieving the desired results with relatively simple equipment.

Aeration is accomplished in a variety of methods, some of which are: flow through stepped-flume sections, over corrugated concrete slabs, forced-draught aerating towers, flow over baffles or from troughs, and by use of settling tanks having large surface exposure.

Most of the systems require pressure on the injection wells only when "breaking down" the formation of the starting of operations. After the injection begins taking water in sufficient volume, the hydrostatic head is sufficient to force the water into the porous sections of the injection horizons. The static fluid level in most wells is around 1000 ft. Building up of back pressures is combated by back-washing or flushing and swabbing the wells to remove bacterial or other deposits from the face of the sand.

Several of the input wells have been drilled primarily as injection wells, but most of them are former oil producers that have been drilled several hundred feet deeper. The wells are drilled to levels below shale-breaks in the lower Woodbine sand, generally at least 100 ft. below the oil–water contact. Most of them are placed near the west edge of the field, but some drilled as injection wells are outside the field's limits.

A. H. N.

1242.* Automatic Production Dispenser Cleans and Meters Oil. T. P. Sanders. *Oil Gas J.*, 9.10.41, **40** (22), 36.—The device described is for removing automatically water and sand and gas from a well's production and then pumping and metering the clean oil. The original installation was so successful that additional wells were soon equipped. As a large-scale undertaking it became very desirable to reduce the per-well investment. First move in this direction was the substitution of 60-brl. scrubbers for the 200-brl. vessels, and next was the adoption of meters having an hourly capacity of 80 brl. as a substitute for the 260 brl./hr. meter of the first installation.

The final improvement took place when an ingenious method was devised for making one meter serve a number of wells. This reduced the number of meters required to a fraction of what would otherwise have been required.

There are now twelve multiple-well hook-ups, each of which uses a single meter for gauging individually the production from four or more wells. The usual scrubbing and metering hook-up is centrally located among four producing wells, which may be either flowing or pumping. Each well produces into its own 60-brl. scrubber. When the level of the clean oil in scrubber No. 1 reaches a selected point, a float makes contact to close an electric circuit. Simultaneously three things happen: a relay switch breaks contact on each of the float-switch circuits of the other scrubbers, thereby making it impossible for any of the other tanks to discharge fluid through the meter before the flow from scrubber No. 1 has been completed; a magnetic valve situated on the oil line between scrubber No. 1 and the meter is opened; in the meter head, a solenoid actuates a lever which shifts gears to engage the registering dial for scrubber No. 1 to the meter shaft.

Opening of the magnetic valve makes a contact to close another circuit which starts the motor of the pump. Oil from scrubber No. 1 is then delivered into the gathering system, its volume being recorded by the individual registering dial, until a selected level is reached where the float-switch will operate to close the magnetic valve, disengage the gears of the registering mechanism, and shut down the pump. If, in the meantime, one of the other separators has filled up past the level at which it is regulated to discharge, its electric circuit controls the same processes. A. H. N.

1243.* **Gas-lift Used for Efficiently Producing Small Lease.** N. Williams. *Oil Gas J.*, 9.10.41, **40** (22), 44.—The paper deals with a particular field where deep sands producing under very low heads and which are troubled with a lot of water are worked. Four wells are used. Requirements of these wells total a little over 650,000 cu. ft. of gas daily, with the plant handling in the neighbourhood of 20,000,000 cu. ft. monthly. Requirements for the individual wells range from 135,000 cu. ft. to about 150,000 cu. ft. daily, the amount varying according to individual conditions and the volume of fluid to be lifted. The volume usually figures out on a basis of about 1800 cu. ft. of gas/brl. of fluid lifted.

Gas from the supply well is delivered to the suction of the compressor at a pressure of 275–290 lb., and is discharged to the well input system at a pressure of 575 lb. Pressures required for operation of the lifts vary according to wells. One well is operating at pressures as low as 350 lb., whilst another takes as much as 500 lb. Operating pressures run from 420–450 lb.

In the wells is a specially adapted bottom-hole gas-actuated pump-type lifting valve designed and made by the operators. It is set and operates in such a way that no outside pressure that might retard the entry of the fluid into the bottom of the hole is ever applied to the producing sand.

The gas-actuated lifting valve is set in the hole with only the length of the fluid-accumulating chamber on the bottom. This chamber, extending through the sand section opposite casing perforations, is a section of pipe-bull plugged on bottom, but equipped with back-pressure valve-operated ports for the entry of fluid. The length of the chamber is governed to accommodate only the volume of fluid to be unloaded at a time, which in these instances is about a barrel. To lift more fluid at a time would require the injection of a greater volume of gas, thereby increasing costs. When the chamber is full the injected gas operates valves to unload the fluid, and shuts off when the chamber is emptied.

A packer seals off the annular space between the casing and the flow-string.

A. H. N.

1244.* **Volume-control Repressuring Successful on Small Lease.** H. E. David. *Oil Gas J.*, 16.10.41, **40** (23), 46.—The particular lease in question has recovered approximately 20,000 brl. oil/acre to date and daily production has been increased by almost 600% since the start of the repressuring programme. The pool, in the past, has produced approximately 220,000,000 brl. of oil from approximately 16,000 acres, and the possibility of recovering a similar quantity in the future is an important factor in Oklahoma's potential reserves.

The project on the Sinclair Prairie Kiefer lease has also revealed important operating data on gas repressuring. It has demonstrated the feasibility of small-scale operations and the results to be obtained from close control of the pressures in a particular area.

One of the principal problems in repressuring a small area in a large reservoir is the prevention of migration of the oil towards the offset properties. The Glenn Pool repressuring project has been very successful in building up the pressure in the sand and increasing recovery of oil on the property under secondary development without causing movement of oil across the lease to the offset properties.

This has been accomplished by repressuring only the centre portion of the 160-acre lease, and by close control of the volumes of gas injected into the pressure wells and frequent checking of the pressures and volumes on all the producing oil-wells. This method allows the engineers to determine when oil and gas in the sand are approaching the boundary lines. Reduction of the pressures and volumes injected will check this migration.

The plan originally called for the injection of a definite volume of 25,000 cu. ft. of air daily into each input well. As the project was expanded, however, this volume was gradually increased until tests of the line-wells on the lease indicated that the air and oil would soon begin migrating off the lease. The volume was then decreased, and at present slightly more than 25,000 cu. ft. of air and gas is being injected.

A. H. N.

1245.* **Filtration Formation Cementing of Low Gas–oil Ratio Wells.** J. I. Laudermilk. *Oil Gas J.*, 23.10.41, **40** (24), 56.—The processes involved in filtration formation

cementing are similar to the functional performance of the old-type charcoal-sand-and-gravel filter used in the purification of water, although naturally in reverse operation. The cement should be injected into the well as an extremely thin slurry, thus permitting it to filter through the more permeable regions of the producing formation and gradually to be strained out or deposited along the paths of the flow-channels, thereby reducing the tendency of the fluid in the reservoir to travel into the well-bore along these particular channels. If this process be continued to its logical conclusion by the injection of a sufficient amount of cement slurry, the more permeable parts of the formation (normally the water-producing zones) will become filled with filtered-out cement particles and clogged in a manner analogous to the clogging of the water-filter mentioned above. In filtering out through the various minute channels of flow throughout the producing formation, the cement will effectively plug these channels and cause the permeability of the portion involved to be greatly reduced. It may be open to question whether or not the cement will actually set in the flow-channels, as in the case of cementing casing, although this does appear to happen to some degree. However, appreciable benefits will be derived from the plugging of the formation by inverse filtration where actual cementation does not occur. Both processes of filtration and cementation are probably present in all cases, and the predominance of the importance of one occurrence over the other may well depend to a marked degree on the sizes of the channels of flow available for induction of the cement-laden fluid into the reservoir.

The total amount of cement which may be injected into a well by filtration formation cementing will vary greatly with the different producing formations encountered in various oil-fields, but will often be of such magnitude as to astonish a beginner in this type of work. The author once assisted in the formational cementing of an unconsolidated sand using this filtration method, in which case more than 1½ tons of cement were injected into the formation without any deposition of cement in the bottom of the well-bore.

It is, of course, possible to place the old-type bottom-hole plug of cement in the well-bore to supplement the effects of filtration formation cementing if such plugging back is unobjectionable. A. H. N.

1246.* Effects of Connate Water upon Ultimate Recovery. Part 1. W. F. Cloud. *Oil Wkly*, 22.9.41, **103** (3), 33.—The work of Hassler, Muskat, Botset, and their associates is reviewed together with Leverett and Lewis's experimental studies on the permeability of rocks to two-phase systems of fluids. From this review it is concluded that: (1) connate water content of only 15% or 20% will have very little effect on the relative permeability of a sand to oil, gas, or water; (2) viscosity has a small effect on relative permeability–saturation relations; (3) a small decrease in oil saturation causes a large increase in gas–oil ratios, higher ratios occurring with higher oil viscosity, provided the oil-saturation percentages are similar; (4) relative permeability as related to saturation is not a fundamental property of all sands, different sands having individual characteristics and gas–oil ratios at similar saturation; (5) different sands require different pressures to start the movement of fluids through them, and a certain pressure will remove only a certain amount of oil, depending on the number and size of capillary openings; (6) from 40% to 50% of the pore space may be filled with water, which remains fixed as oil and gas are produced; (7) the amount of water remaining fixed in a sand will depend on sand-grain size, specific permeability, and pressures applied.

The amount of water remaining in reservoir pore spaces after gas-expansion flow or gas-lift operations cease is a matter of prime importance when the application of gas injection or water-flooding is considered. The amount of this water must be determined from cores on a pore space percentage basis, and must be considered in calculating the amount of unrecovered oil in place before a field or lease can be intelligently subjected to secondary-recovery methods over a period of years. Laboratory investigations indicate that ultimate recovery of unsaturated oil is appreciably affected by the presence of various amounts of water existing as a coating on sand-grains and at their points of contact.

Experimental work on gas-drives is reviewed. The work of Mills, Krutter, and the author might be interpreted as indicating that, regardless of sand texture, porosity, compaction, and permeability, only approximately 50% of the original oil can be

recovered by gas-drive under ideal conditions from either consolidated or unconsolidated sands, provided gas-oil ratios are disregarded and viscosities and temperatures are similar. A. H. N.

1247.* Sanding-up Problem Solved in New California Completion. G. M. Wilson. *Oil Wkly*, 29.9.41, **103** (4), 27–28.—A new method of completing a well which is characterized by having excessive amounts of fine sand is described and illustrated in detail. The equipment consisted of the following: A special set shoe was made up on the first joint of screen to be lowered into the hole. The shoe used contains a back-pressure valve, and has several holes in the bottom to enable fluid to be forced through it, permitting the liner to be jetted down past any obstruction that may be encountered in the open hole. The shoe also contains a pressure-tight connection, into which the tubing latches while the assembly is being lowered into the well, and which will release the string on rotating to the right.

The last section of liner to be run into the hole was hung in the rotary slips, and a single joint of tubing, with special latch-on tool made up on its lower end, was run in to the bottom of the set shoe, where four or five turns of the tubing to the left securely anchored it in the bottom of the shoe. Sufficient tubing was run to cause it to protrude 2 or 3 ft. above the top of the liner still hanging in the slips of the rotary table. A packer-setting tool was next made up on the top of the tubing. A section of tubing was then picked up with the elevators, and the packer pulled up over the section and held by the cat-line while the tubing was screwed up into the setting tool.

After setting the packer and circulating oil, the tubing can be removed without killing the well, as was necessary in the conventional methods. A. H. N.

1248.* Effects of Connate Water upon Ultimate Recovery. Part 2. W. F. Cloud. *Oil Wkly*, 29.9.41, **103** (4), 29.—When artificial water-flooding is first applied to partly depleted oil-sands no increase in oil production is immediately forthcoming, because the capillary "creep" of the water is very slow—perhaps less than 100 ft./year in the Bradford area. However, the rate at which water will move through sands will depend primarily on sand texture, pressure applied on the injected water, per cent. of remaining oil saturation, and the relative surface tensions of oil and water. It is characteristic for only oil and no water to be produced at recovery wells during the period when the oil is being pushed as a "bank" in front of the water network. The first appearance of water with the oil is usually accompanied by a marked reduction in oil production, after which the water production increases and oil decreases until the arbitrary economic limit of water-oil ratio is obtained. Regardless of whether the injected water permeates the sand-body as a circle, ellipse or lemniscate apex, the net result is the pushing of oil from several directions towards one pumping well, which is centrally located with respect to the surface pattern of well-spacing used. The mechanics of artificial flooding is probably two-dimensional and only slightly affected by gravity in most sandstones.

Factors which affect the entrainment or capillary retention of oil in sands after the gas has been depleted are the surface tension of the oil, the angle at which the oil makes contact with the sand-grains, the texture or uniform fineness of sand-grains, the surface area of sand-grains exposed to oil, and the relative densities of oil and water. The viscosity of the oil is not a prime factor, but if connate water is present at the points of contact of sand-grains, interfacial tension will be an important factor.

Laboratory procedure and results are reported on oil recovery. Water-flooding after gas-drive causes very little reduction in crude-oil gravity. There was no consistent relation between water-drive recoveries and water-oil ratios. Apparently recoveries by water-flooding are not correlative with porosity, but permeability seems to be directly related. Also, the rate at which water was injected portrayed no tangible effect in this sand except the time factor.

In all these tests the recovery by water-flooding was abnormally high, as compared with that of consolidated sandstones. This indicates that in highly permeable sands the capillary pressure is low, and all the forces acting at the contact points of sand-grains are subordinate to the hydrostatic pressure of the driving liquid. It is presumed that the 26-6% of the original oil remaining existed as a very thin film around each sand-grain, the amount of retention of each grain being dependent on capillary radius and grain-surface area. A. H. N.

1249.* Model for Study of Oil Recovery Problems. J. S. Levine, L. T. Bissey, and S. T. Yuster. *Oil Wkly*, 29.9.41, **103** (4), 34.—Although various models have been constructed to study fluid flow, they have dealt primarily with single, homogeneous fluids. A five-spot model has been designed and constructed for the purpose of studying the flooding of an unconsolidated sand. The apparatus is made of transparent Plexiglass, so that the actual flooding patterns can be seen during various stages of the flood, and the model is adaptable to various pattern arrangements.

The actual water-flooding of Pennsylvania crude oil from an unconsolidated sand is shown in a series of photographs taken during phases of the flood. They show the method of fluid migration from input to producing well, and also indicate the extent of the "dead areas" after the recovery period has ended. Curves are given to show the actual volumes of oil and water produced and the water–oil ratios during production.

The value of this experiment lies chiefly in the qualitative results obtained from the photographs of the flood. While not startling in themselves, they bear out theoretical conclusions as to the manner in which a five-spot pattern is flooded. The experiment also shows that most of the recovery is obtained in the early period of the flood, and that once water is produced, the oil production rapidly decreases. The results would also indicate that pattern rearrangement will produce little residual oil. However, this conclusion is not entirely valid, since it undoubtedly depends on the amount of residual oil present. In this case the initial recovery was high, so that but little oil remained. The recovery was higher than would normally be expected, and greater, in fact, than previous flooding of unconsolidated sand had produced.

The paper is well illustrated by the photographic results of the experiment, and the treatment is given in detail. A. H. N.

1250.* Easy Means Evolved for Constant Gas–Oil Ratio Checking. Anon. *Oil Wkly*, 6.10.41, **103** (5) 46.—In one pool in Oklahoma a constant check is maintained on the gas–oil ratio. Gas measurement procedure is solved by means of a pitot tube and differential recording orifice meter on a Sunray Oil Co. lease. The tube is bent in a curve at the upper end and inserted in a short section of 4-in. pipe. Gas is directed from the separator through a 25-ft. section of buried pipe and released at the vertical 5-ft. vent-line. A rubber hose connection is effective between the bent metal tube and the orifice meter. A 24-hr. continuous rotating chart is provided to record the changing differential.

An auxiliary 7-in. vent-line, 15 ft. in height, is available for exceptionally high gas capacities. The two vent-lines are joined at base to the common carrier underground, and a valve control has been inserted at base of larger vent-line. A. H. N.

1251.* Steel Lease Tanks. G. B. Nicholson. *Oil Wkly*, 13.10.41, **103** (6), 17.—This article is limited to steel tanks, and covers, in some respects, land operations only, being roughly divided into two sections as follows: (1) Tank specifications to consider before buying; (2) suggestions for installation, operation, and maintenance. In view of the defence emergency and the accompanying steel scarcity, it is more important than ever to get the greatest amount of service out of tanks.

The various precautions to be taken in reducing evaporation losses are discussed individually. Recent practices in certain details regarding clean-outs and ventilation are given. An improvement which has been considered for tanks is a flat steel plate welded to the floor directly beneath the thief-hatch for a gauging plate, to simplify obtaining accuracy by assuring a level surface on which to rest the gauge-line plumb-bob. The plate usually extends higher than the floor level, but the gauge is not affected, as tanks are never completely emptied to the bottom during pipe-line runs. An additional advantage is offered by the plate in protecting the bottom of tanks from the point of the plumb-bob, which in many cases has weakened tanks in the area below the hatch opening and allowed the floor to be eaten out. Further accuracy in tank gauging is obtained by erecting a vertical interior-pipe, bolted firmly in place, with the top inside the thief-hatch, and its lower end, open and perforated, extending to a point below the fluid level. The liquid surface inside the pipe is free of surface agitation, lacking the foam that is ordinarily present. The gauge-line is run inside the pipe, and fluid-marks on the line give a true indication of the amount in storage.

Care must be taken to ensure that inside pipes give correct reading of oil and water contents. Below the hatch openings in modern tanks steel shelves are placed for the gauger's convenience.

Installation is similarly given in great detail. Concrete is recognized as the best foundation material, although it is not often used. However, if the tanks are expected to serve one lease over a long period, the additional expenditure will reap dividends in the future. Under ordinary conditions an earthen base is sufficient for support, as the load of a 16-ft. tank filled with oil seldom exceeds a ½ ton/sq. ft., and usually soil carries from 2–5 tons/sq. ft. without difficulty. In swampy territory it is sometimes wise to construct foundations with a wide concrete apron extending from under the tanks, to distribute the load over a broader area, and to add to the load-supporting capacity of the soil.

This extensive paper is well illustrated. A. H. N.

1252.* **Function of Relative Permeability in Water-Flooding.** L. C. Converse. *Oil Wkly*, 31.10.41, **103** (6), 28.—The six variable factors entering into the complex problem of fluid-flow as applied to water-flooding may be divided into two groups: (*a*) the reservoir conditions as found existing, over which the operator has no control, and (*b*) the variables over which the operator has control within definite limits.

The three incontrollable factors combine to make the important factor of relative permeability, the function of which is threefold: (*a*) as between reservoirs, (*b*) as between wells within the reservoir, and (*c*) between zones within the well-bore. Assuming oil present in commercial quantities, the application of the controllable values to the uncontrollable values makes the economics of any flooding project. Each of the factors is discussed separately. The uncontrollable factors are sand permeability and per cent. saturation (oil), and the viscosity of the oil. The controllable factors are pressure, distance (spacing), and diameter of input well.

In the modern concept viscosity is an integral part of specific permeability; however, the more obsolete idea gives emphasis to the point if we say that relative permeability is the variable of dry permeability plus the variable of per cent. of oil saturation plus the variable of viscosity as functioning between reservoirs. Since spacing has such large influence on the economics of a flood, and since viscosity has the largest influence on spacing, the importance of having this factor correct should be mentioned. The samples to be taken to the laboratory for viscosity determination should be taken at the wells from the last of the day's pumping in a pressure container with all air excluded. For interpretative use the viscosity should be run at the reservoir temperature. To get the true temperature an old well which has been static for a long time should be used.

Pressure and input well diameter, together with relative permeability, determine the spacing, and all of them put together determine the average take per foot of sand. The average take and the spacing determine the time interval necessary to displace the oil in the sand within the sphere of influence of the input wells. After the first few weeks of controlled flow the radial advance of the water would be far less than the optimum rate, even if the wells were taking 10 or 15 brl/day/ft. of sand. This being the case, take controls the economics of flooding, and instead of being limited, every advantage should be used to induce the maximum average take.

The average take per foot of sand/day for the Mid-Continent floods is less than 1·5 brl., which requires 5·5 years to displace the oil within a 330-ft. spacing pattern. This take gives an average radial advance of 1·36 in./day, which is obviously too slow for the average permeability of the sand and viscosity of the oil. The only change which would result if the take were increased to 4·5 brl./ft. of sand/day would be an economic one. With the spacing remaining the same, the time required would be reduced from 5·5 years to 1·8 years. Three times as much acreage could be developed and three times as much oil produced in the same period.

But, better still, if the wells averaged 4·5 brl./ft./day the spacing could be broadened to 440 ft. from like well to like well, and the time reduced to 3·5 years. Approximately a third would be saved in development cost, and two years in time. With much worse than average conditions the author has been able to introduce 5 brl./day/ft. of sand, whilst with better than average conditions he is now introducing 20 brl./ft./day.

Economics are further discussed. A. H. N.

1253.* Unusual Features in Successful Co-operative Repressuring of Loma Novia Field. T. Davison. *Oil Wkly*, 20.10.41, **103** (7), 17.—The first year of repressuring at Loma Novia shows promise of good final results. This project is particularly interesting for two reasons. First, it is unusual in that twelve operators having thirty small leases in a field can co-operate in a repressuring programme, disregarding property lines in the selection of key wells and input volumes. Second, the programme is unusual because only the excess power from the pumping engines is used to drive the compressors.

The location of the field and its development are discussed in some detail.

The injection of gas into an oil-producing formation not only forms a gas-drive, but also makes the oil more fluid. As the gas which was originally in the oil is spent, the oil not produced becomes more viscous and has less tendency to flow to the producing wells. Even in areas where the injection pressures are as low as 20 lb., the gas has an effect on the viscosity of the oil. At this low pressure not much of the gas can actually go into solution, but it is believed that the gas dissolves in the oil, making it less viscous and easier to drive or drain to the producing well.

After a long discussion the paper concludes thus: "A co-operative repressuring project can be successfully carried out even though there are small leases and many operators in a field."

Mainly because of the lack of reservoir energy, and the large quantity of oil remaining in the sand, good results are shown and anticipated from the repressuring. Full utilization of the original power available is being made; none of the operators have required additional power equipment to drive the compressors.

As periodic gas–oil ratio tests have been made and the injection volumes closely correlated with oil and gas production, none of the wells are in serious condition because of bypassing or channelling. The injection volumes required to show results are less than the produced gas volumes, although it is anticipated that more than the present produced gas volume will need to be injected to obtain the best results.

On all repressured leases the oil-production decline has been retarded. Some leases have shown a flattening of oil-production decline, and other leases have shown an increase in oil production in the past few months. The increase in ultimate recovery due to repressuring of the 220 wells in the co-operative area is estimated to exceed 800,000 brl., or 3640 brl./well. A. H. N.

1254.* Effects of Sand Grain Size Distribution upon Porosity and Permeability. W. F. Cloud. *Oil Wkly*, 17.10.41, **103** (8), 26.—The factors which affect the porosity of a sandstone are as follows: (1) the character and amount of cementing and colloidal materials, (2) the hardness or degree of compaction, (3) shape of grains, (4) arrangement of grains, and (5) the uniformity of grain size or distribution. Uniformity of grain size and shape are important factors. For example, it can be demonstrated both physically and mathematically that a gallon of No. 8 chilled shot will be just as porous as a gallon of No. 4 shot. But a 50–50 mixture of the two will have the least porosity.

Frequently very finely textured sandstones have a higher porosity than coarse sandstones, although the permeability of the latter will be much greater. Generally, if the grain shape is fairly similar throughout the various sizes and percentages of size distribution, porosity will increase and permeability will decrease as the range of finer sizes increases. For example, the average porosity of sandstones is 15·5%; whereas that of silts and clays is 50%. If two sizes of similar sands are mixed, the porosity and permeability can be made to vary with each other as the per cent. of each component size is made to vary above or below a 50–50 mixture.

A discussion is given on sieve analysis and methods of reporting results.

Professor Cloud examined ten representative cores from ten different oil-fields located in widespread areas of the U.S. After the water and oil had been extracted, each core was dried, then drilled for a permeability sample. The scraps remaining were used for sieve analysis and porosity determination. Sieve samples were prepared by first crushing to pea size in a vise. Sieve separation of the coarse and fine particles at this stage provided coarser material for chemical separation by use of sodium acetate, and finer material for hand crushing or mild use of mortar and pestle. A binocular microscope was used to determine when complete grain separation had

been accomplished. Several preliminary sieve sizings were necessary for most of the samples. Each prepared sample was weighed, then placed upon the coarse sieve in the conventional nest of eight sieves in the series. Each sample was shaken for 45 min., using a commercial machine designed for this work. Porosities were determined by using a modified Washburn-Bunting process. Permeabilities were determined in the conventional manner, using dried air at several differential pressures. The comparative results of all tests have been compiled graphically. The McClosky cumulative percentage curve is typical of colitic limestones. The permeability is very high, but the porosity is not what might be imagined unless it is recalled that there is a lack of correlation between these two properties. Of the entire group, the Woodbine sand shows the best correlation between high porosity and high permeability. This is typified on a block diagram by an appreciable coarse-size distribution and a broad " node " in the region of 65–150 mesh. The abnormal amounts of silt and colloidal material in the region of the 150-pan sizes of the Benoist, Bartlesville, Glenn, and California sand is indicative of higher than average (15·5%) porosity. On the contrary, the same conclusion is misleading for the Bradford sand, the cementing material of which is primarily secondary silica. Also the Bradford sand is too hard to be crushed accurately. The block diagram of the Layton sand portrays good porosity and fair permeability. One might expect low permeability through the Bradford, Bartlesville, and Blue Jacket sands after inspection of the curves and block plots. The Wilcox sand portrays perhaps the best " balanced " plot of the group.

As a result of these physical examinations, the author believes that for the average angular-grained sandstone of medium hardness, when the ratio of the sum of the two smallest size percentages to the percentage retained on the 100-mesh (region of normal node) is 0·50 or more, the permeability will be fair to good, and the effective porosity will be 20% or greater. A ratio lower than 0·50 will, of course, usually indicate a porosity less than 20% and low permeability, depending on grain shape and character of cementing material. A. H. N.

1255.* Critical Analysis of the Application of the Back-pressure Method in Studies of Gas Reserves. Part 1. J. W. Ferguson. *Petrol. Engr*, September 1941, **12** (13), 34.—The paper points out the correct mathematical methods of dealing with back-pressure curves. The characteristics of logarithmic scales are discussed as an introduction. The usual formula used is $Q = C_1(P^2)^n$ or written in logarithmic form: $\log Q = \log C + n \log (P)$.

The usual procedure employed to obtain a curve representing the performance of a group of natural gas wells is to choose certain values of P^2, such as 10,000, 20,000, 40,000, 80,000, and 100,000, or any others thought advisable. Then the value of Q corresponding to each of these values of P for each well is calculated or read from the back-pressure curves, and tabulated. These values are then added, group by group, to obtain a composite value of Q corresponding to each value of P^2. These are then plotted, and the resulting curve is considered to be the composite curve for the group of wells.

Other methods are advanced elsewhere, due to the fact that the effective reservoir pressure is difficult to calculate. One of these methods was put forward by P. C. White, and the rest of the paper reveals errors in the reasoning of the method.

The effective formation pressure, together with the conventional composite curve, possess the advantage of the composite curves not being changed so long as the individual well-curves remain the same, and any changes in individual well-formation pressures will simply change the effective formation pressure; as it is impossible to predict with any degree of accuracy the changes in individual well pressures over a period of years, this effective pressure is as accurate a basis to begin from in predicting future effective pressures as is any other pressure that might be determined to be an " average " or " weighted average " pressure. A. H. N.

1256.* Progress of Intermittent Flow Devices for Producing Oil. Part 1. S. F. Shaw. *Petrol. Engr*, September 1941, **12** (13), 80.—The history of intermittent flow devices and methods is given. At the present time, the methods might be classified as follows:

1. No chamber, packer, or valve in the wall. Gas admitted to casing or tubing,

and flow is through the tubing or casing. Gas admission valve usually at the surface operated by: (*a*) manually, (*b*) tipping cylinder, (*c*) clock intermitter, (*c*) electric motor.

2. Valve in tubing; no chamber or packer (open type). Gas admitted through the casing and into the tubing through a valve operated by: (*a*) differential pressure, (*b*) wire line, (*c*) lifting or rotating the tubing.

3. Two tubing strings with chamber and standing valve; no packer in casing. (*A*) Gas admitted to annular space by (*a*) surface intermitter. (*B*) Gas admitted to the tubing and flowed through the annulus by: (*a*) manual operation, (*b*) tipping cylinder, (*c*) time-cycle intermitter, operated by clock movement, (*d*) electric motor and magnetic valve, (*e*) differential gas pressure, (*f*) lifting or rotating the tubing, (*g*) liquid-operated valve, controlled by gas pressure.

4. Packer and valve; no chamber (closed type). Gas admitted through the casing and then through ports into the tubing through valve operated by: (*a*) differential pressure, (*b*) wire-line intermitter, (*c*) lifting or rotating the tubing.

5. Packer, chamber, and valve. (*A*) Gas is admitted through the tubing and flowed through casing by surface intermitter. (*B*) Gas admitted through casing, entering chamber through valve operated by: (*a*) differential pressure, (*b*) wire-line intermitter, (*c*) lifting or rotating the tubing, (*d*) surface intermitter.

6. Plunger-lift.

Each type is discussed separately and illustrated.

This extensive paper concludes with the following general remarks: Surface injection of gas in intermittent flow does not necessarily require that a packer be set in the well, whereas injection from a point within the well usually includes the setting of a packer. With two tubing strings, as in Type 3, however, the admission of gas can be partly controlled by a valve operating on a differential pressure near the bottom of the well, and partly controlled by an intermitter on the surface.

When a packer is employed, the admission into the eductor may be made by means of a differentially-operated valve placed at a point close to the bottom of the well, or by means of a valve mechanically operated from the surface.

Each of the methods of positive control handled from the surface has its advantages and disadvantages. The wire-line method is less cumbersome and more easily operated than lifting of the tubing, but it is not readily adaptable to the handling of more than one set of valves. The frequent breaks when wire lines were operated in salt water have been materially reduced by the use of improved stainless steel wire lines when operating in corrosive fluids.

The method of lifting and lowering the tubing for intermitting involves the handling of a heavy string of tubing many times/day, and especially in a deep well, may gradually develop weakness in the coupling threads and cause parting of the tubing. On the other hand, it may be made to handle more than one set of valves when such becomes necessary.

Advantages of intermittent flow, more particularly when fluid levels are low, are those of increased production over the use of continuous gas-lift flow, and the use of less input gas/brl. of oil lifted.

Disadvantages of intermittent flow are those of more complication than in straight gas-lift, and the necessity of using moving parts in a well that gets out of order from time to time, and make a pulling job necessary. A. H. N.

1257.* Calculation of Theoretical Productivity Factor. H. H. Evinger and M. Muskat. *Petrol. Tech.*, September 1941, A.I.M.M.E. Tech. Pub. No. 1352, 1–13.—A method has been developed whereby the productivity factors of producing formations may be calculated from a knowledge of the reservoir conditions. Account is taken not only of the heterogeneous character of the gas–oil flow system, but also of the detailed variations with pressure of the shrinkage and viscosity of the oil, the solubility of the gas in the oil, and even the variability of the gas viscosity and the deviation of the gas from ideal behaviour. Curves give the results of numerical calculations on the production rate as a function of the pressure differential for a high-pressure and a low-pressure system, three values of gas–oil ratio being treated in each case. The curves show that even for a fixed gas–oil ratio and fixed behaviour of the fluids produced, the productivity factor is not a constant, but varies with the rate of production, as is actually observed in practice. The productivity factor depends not only on the

detailed characteristics of the fluid and sand, but also on gas–oil ratio, pressure differential, and absolute pressure. Strictly there is no productivity factor that can be assigned to a gas- and oil-producing system with any range of validity, and a practical definition would be its restriction to the limiting slope of the rate of flow-pressure differential curve as the pressure differential is made vanishingly small.

Curves are also given showing the variation with distance from the well of the pressure, oil saturation, and permeability. The effect of connate water is briefly discussed in relation to the apparantly large discrepancies between the calculated and observed productivity-factor values. G. D. H.

1258.* **Natural Gas Hydrates.** D. B. Carson and D. L. Katz. *Petrol. Tech.*, September 1941, A.I.M.M.E. Tech. Pub. No. 1371, 1–8.—Natural gases under pressure form crystalline hydrates with water. Experimental data are presented for the four-phase equilibrium for methane–propane–water, methane–pentane–water, and methane–hexane–water systems. Temperatures and pressures for equilibrium between gas, water-rich liquid, hydrocarbon-rich liquid, and hydrate were measured, as well as the percentages of methane and propane in the hydrate. The data indicate that natural gas hydrate behaves as a solid solution, and that pentanes and heavier hydrocarbons do not enter into the solid phase. Vapour-solid equilibrium constants are presented which permit estimation of the conditions for hydrate formation from the composition of a gas. G. D. H.

1259. **Sampling Gas-condensate Wells.** J. M. Flaitz and A. S. Parks. *Petrol. Tech.*, September 1941, A.I.M.M.E. Tech. Pub. No. 1374, 1–12.—Subsurface samples from gas-condensate wells are too small for the accurate determination of the heavier hydrocarbon components with normal equipment, and whilst an ordinary oil and gas separator will serve as a sampling device, phase relationships cannot be determined readily because of the difficulty of controlling temperature and pressure. However, if a sampling tube is introduced into the well tubing and material is drawn off at a rate which agrees with the velocity conditions in the tubing, a representative sample is obtained. A portable testing apparatus has been designed for use with the sampling tube.

The results of tests with a standard separator and the portable separator are tabulated. The maximum difference in condensate yield was 10%, but the deviation is much less on the basis of composite analyses. Curves show the relationship between separator pressure and the amount of separator condensate for six typical Gulf Coast fields at 100°, 80°, and 60° F., and data are plotted which can be used to predict the loss of condensate in the reservoir resulting from pressure reduction for the six fields. G. D. H.

1260. **Use of Brine in a Kansas Field for Secondary Recovery of Oil.** C. J. Wilhelm, S. S. Taylor, W. C. Holliman, and E. O. Owens. U.S. Bur. Mines. Rep. Invest. No. 3573, June 1941.—This report embodies findings of the Bureau of Mines in connection with the use of brine instead of fresh water in the secondary recovery of oil. It includes a detailed description of the flood project in Eastern Kansas, and North-eastern Oklahoma and sets forth general conclusions reached from an analysis of the data collected which it is suggested might be useful in initiating new projects.

The use of brine, when properly conditioned, is recommended as a flooding medium in areas where fresh water is limited or contaminated by brine produced in flooding. Its chemical characteristics should, however, be checked, together with those of brine in the formation to ensure that a mineral salt will not precipitate as a result of the two brines mixing in the formation.

Supersaturation of bicarbonates should be determined by chemical analysis and so reduced that precipitation will not occur in any part of the brine-distributing system. Moreover, oxygen content of the conditioned brine should be maintained at a minimum, since dissolved oxygen is a controlling factor in the corrosiveness of a brine to steel.

Such precautions having been taken, it was found on one lease that 8·7% of the original volume of oil was recovered before flooding and 21·3% by flooding. The average ratio of the volume of brine injected to the volume of oil produced was 14 to 1, and characteristics of oil recovered over a 20-month period showed only slight modification.

Further, results of a detailed survey showed that injected brine did not increase the salt content of the produced oil. H. B. M.

1261. Technical Research by the Bureau of Mines in Oil and Gas Production, Refining, and Utilization. H. C. Miller and G. B. Shea. U.S. Bur. Mines. Inf. Circ. No. 7173, August 1941.—The United States Bureau of Mines has a direct mandate from Congress to engage in research in oil and natural gas production, chemistry, refining, and utilization. It puts this mandate into effect through the Petroleum and Natural Gas Division, which studies technical problems of the industry, and the Petroleum Economics Division, which takes care of the statistical side.

This report indicates that research undertaken by the Bureau is not of a type usually carried out by industrial workers, although it embraces findings of a practical nature as well as those which do not appear to lead directly to the solution of immediate operating problems. The establishment of five field headquarters in major oil-producing areas, close co-operation with individual companies, groups of companies, industrial organizations, trade associations, and various States and State agencies and other factors have made unique the position of the Bureau of Mines as a fact-finding agency. Probably no other research agency has available to it so many facilities for the efficient conduct of research.

At the present time the production section is attaching great importance to the question of the fluid and energy relations in petroleum reservoirs, in order to indicate to the industry how best available energy can be utilized to obtain optimum recovery. In this connection problems concern gas–oil ratios of producing wells and fields, and the effect on ultimate recovery of changes in volumes of gas produced with oil; collection and examination of subsurface samples of crude oil to determine data on saturation changes, thermal contraction and changes in specific gravities of oils; physico-chemical properties of natural hydrocarbon mixtures, flow of air and gas through reservoir sands; and permeabilities and porosities of oil-bearing sands and rocks.

In its aim to establish more efficient utilization of petroleum through greater knowledge of its constitution and transformation into merchantable products, the chemical and refining section of the Bureau has paid special attention to the fractionation of crude oil by distillation at atmospheric pressure, vacuum distillations, and the use of solvents. Various petroleum fractions have been evaluated from the point of view of suitability for the manufacture of lubricating oils, diesel fuels, cracking stocks, etc.

In addition, the special chemical and engineering research branch of the Bureau has undertaken the study of a variety of problems connected with evaporation losses of petroleum and its products, contamination of potable waters by brines, use of cements and mud fluids in oil- and gas-wells, and mechanical, hydraulic, and chemical methods of cleaning oil-wells, etc.

Results of Bureau of Mines research in all these branches of the industry are made available through bulletins, technical papers, reports of investigations, information circulars, and special reports, some of which are classed as monographs. H. B. M.

1262. Petroleum Engineering Study of the Anahuac Field, Chambers County, Texas. C. B. Carpenter and H. J. Schroeder. U.S. Bur. Mines. Rep. Invest., No. 3579, August 1941.—The authors of this report state that their chief aim was to increase the accuracy of existing methods of estimating reserves by applying all the data collected during the modern development of an oil-field. The field chosen for detailed study—the Anahuac—ranks fourth among Gulf Coast oil-fields in estimated ultimate recovery, and presented many advantages from the point of view of collation of petroleum engineering data. The producing formation is very thick; every modern technique of drilling and development, including micropalæontological coring, electric logging, determinations of porosity, permeability and connate water, subsurface sampling of crude oil, and periodic depth-pressure measurements, has been applied; complete records of all operations, including detailed surface information, have been kept; the field has been developed systematically; and every effort has been made to utilize reservoir energy efficiently.

The conclusion is reached that the ultimate recovery of crude oil and natural gas from a field of the Anahuac type, which is heavily faulted, is most accurately estimated by the porosity-saturation method. This involves computation of net volume of

the producing formation in the reservoir from subsurface records of wells, and determination of porosity, saturation, and shrinkage of oil by analysis or experiment.

Recovery which cannot be determined by analysis or experiment is based on records of depleted or nearly depleted fields having similar characteristics, or on theoretical considerations.

Thus estimated ultimate recovery of oil is calculated from the equation

$$R = \frac{7{\cdot}758\ Vpsy}{1 + x}$$

where R = recoverable oil (brl.); V = net volume of reservoir (acre-feet); p = effective porosity (%, expressed as a decimal); s = oil saturation of effective pore space (%, expressed as a decimal); x = volume increase of residual oil from 3235 lb. per square inch absolute to atmospheric pressure (%, expressed as a decimal); y = estimated oil recovery (%, expressed as a decimal), and 7758 = volume of 1 acre-foot expressed in brl. (42 gal.). H. B. M.

1263.* Laboratory Study of Water Encroachment in Oil-Filled Sand Columns. F. G. Miller. U.S. Bur. Mines Rep. Invest., No. 3595, October 1941.—The author of this report emphasizes the need for proper understanding of the phenomenon of edge-water encroachment if natural-water drives are to be used successfully in the recovery of oil from reservoir rocks.

At first the presence of edge-water was regarded as a necessary evil. More recently, however, it has come to be regarded as an integral part of the reservoir fluid and a source of energy for propelling hydrocarbon fluids through the reservoir and to the surface of the ground.

Many laboratory studies of edge-water encroachment were undertaken in earlier years which, although giving much valuable information, in general only yielded qualitative results. Thus, in view of the growing interest of the petroleum industry in the problem, the Bureau of Mines undertook an extensive laboratory investigation of water encroachment in oil-sands. The results of the first part of this research are the basis of this report, and are designed primarily to supply laboratory data on one aspect of the general problem, and not necessarily to supply information for field application.

These data concern relationship between rate of water encroachment and percentage of oil recovered by a water-drive from similar previously oil-filled sand columns; also to a lesser degree the influence of absolute sand permeability on recovery of oil by water drive.

In the course of investigations described in the report, specially prepared oil-filled columns of unconsolidated sand were flooded with water at flooding rates of the same order as rates of edge-water encroachment in actual reservoirs. The conclusion reached of principal interest to petroleum engineers is that, under certain idealized laboratory conditions and within a definite range of low water-encroachment rates, the percentage of oil recovered increases with the rate of water encroachment. Further, it is concluded that the influence of rate of water encroachment on oil recovery is more pronounced at lower than at higher rates.

It is suggested that much additional fundamental laboratory research is needed before the principles underlying the behaviour of encroaching edge-water in oil-productive formations will be understood; also that investigations of the rate and manner of edge-water movement in petroleum reservoirs should be continued in order to correlate laboratory studies with actual reservoir performances. H. B. M.

1264.* Technical Contribution to Petroleum Conservation. F. Penn. *World Petrol.*, October 1941, **12** (10), 42–45.—A brief review of conservation concepts and its lack in early production practices is given. In the modern concept of well-completion it is usual to consider one or more, and sometimes all of the following steps in completing a well efficiently as a preparation for applying the principles of conservation throughout the entire useful life of the well:

The setting of one or more strings of casing to prevent the migration of fluids from one formation to another, whether they contain oil and gas, potable waters or other fluids.

The use of electrical logging and sidewall sampling, or other coring devices to investigate thoroughly every possible oil- or gas-producing horizon that might have been passed in drilling.

The use of the more recently developed method of γ-ray logging, either to correlate formations or to determine the success of the cementing operation when cement containing radio-active material has been employed.

The use of acid or other chemicals for the various purposes of (*a*) increasing the porosity of limestones and more recently of sandstones, (*b*) making the surface tensions of oil and water more nearly comparable, so that natural flow can be more easily established, and (*c*) for a general cleaning up of the producing formation to increase the productivity of the well.

The scraping of walls or the underreaming of a hole in order to increase the effective area of the producing formation.

The use of gravel-packing as a means of combating the tendency of loosely consolidated sand formations to slough-off and fill the well-bore.

The list could be added to indefinitely if each minor variation were to be mentioned, but the above are examples of the methods coming into use every day, all with the sole objective of increasing the efficiency whereby oil-wells are prepared for the all-important task of producing oil with as little underground waste as possible.

Conservation is also practised in improving the methods of producing and treating oils and emulsions. Thus the author carries the concept into the domain of refining and cracking as methods of conserving oil. A. H. N.

1265. Patents on Production. A. M. Gurley. U.S.P. 2,253,780, 26.8.41. Appl. 30.10.39. Hydraulic pumping unit for deep wells.

P. G. Exline. U.S.P. 2,254,006, 26.8.41. Appl. 10.11.38. Apparatus for testing well-samples.

C. S. Crickmer. U.S.P. 2,254,060, 26.8.41. Appl. 20.4.39. Packing element for an oil-well packer.

C. S. Crickmer. U.S.P. 2,254,061, 26.8.41. Appl. 30.10.39. Adjustable kick-off valve for flow devices.

L. V. Hull. U.S.P. 2,254,148, 26.8.41. Appl. 18.10.40. Pump-jack bearing.

A. Boynton. U.S.P. 2,254,207, 2.9.41. Appl. 28.11.38. Bellows-type stage-lift for wells.

G. E. Ostrom. U.S.P. 2,254,443, 2.9.41. Appl. 14.6.38. Method of treating wells with mono-chloracetic acid together with magnesium and phosphorus pentachloride to increase production.

G. L. Thompson and L. A. Cejka. U.S.P. 2,254,554, 2.9.41. Appl. 10.4.39. Well-pump with gas-line to control a valve.

C. V. Temple. U.S.P. 2,254,631, 2.9.41. Appl. 2.9.37. Gas-lift valve with a spring tending to open the valve.

Q. J. Penick. U.S.P. 2,254,752, 2.9.41. Appl. 25.9.37. Well-head assembly with retractable supporting means.

C. A. Ricou. U.S.P. 2,254,979, 2.9.41. Appl. 9.10.39. Screen cleaning gun.
A. H. N.

Transport and Storage.

1266.* Gas Storage at Low Temperature Increases Effective Capacity of Spherical Tanks. A. F. Davis. *Petrol. Engr*, July 1941, **12** (11), 100.—A gas-storage project is described in which three steel spheres are equivalent in capacity to 150 conventional gas-holders. The unique feature is the reduction ratio of 600 to 1 in liquefaction and the extremely low temperature (248–250° below zero) at which the gas is stored.

Each sphere consists of an outer shell containing 3 ft. of cork insulation on which the inner sphere "floats." The erection represents a new industrial advance made practicable by welding, and a large part of the article is devoted to details of the construction job of the alloy steel plate multi-segmented spheres, utilizing the shielded arc process. J. C.

Gas.

1267.* Safety Standards of Liquefied Petroleum Gas Industry. G. L. Brennan. *Oil Gas J.*, 14.8.41, **40** (14), 49.—A brief graphical review of the development of the liquefied petroleum gas industry is followed by a description of the method of preparation of safety standards in the industry and their adoption by the National Board of Fire Underwriters. A list is given of the more important publications with details of the basic rules in pamphlet No. 58 covering odorization of gases, examination and listing of equipment and systems, construction of cabinets, location of containers and regulating valves, container valves and accessories, hose specifications, safety devices, filling densities, and transfer of liquids. C. L. G.

Cracking.

1268. Refining Oil—Synthesis Primaries. Anon. *Chem. Tr. J.*, 10.10.41, **109**, 174.—Reference is made to a paper given by H. Velde before the German Society for Mineral Oil Research published in *Oel und Kohle*, in which a description is given of a modified catalytic process developed by Ruhrchemie A.-G. for the production of synthetic gasoline by thermal cracking. The process consists of single-stage cracking of the crude gasoline separated into different fractions, thereby raising its octane number from 55 to 65. The reactions include isomerization of straight-chain to branched compounds and of olefins (shifting of double bond from the end towards the middle of the molecule). Work has also been carried out on the polymerization, isomerization, aromatization, and catalytic cracking of fractions of synthesis products. The primary gaseous products are also polymerized with phosphoric acid catalysts at 60–80 atmospheres and temperatures below 250° C. to gasoline. Saturated gases are either used as fuel or dehydrogenated for subsequent polymerization. New catalysts for isomerization, that give considerable branching of the carbon skeleton, are claimed. C. L. G.

1269. Cracking Patents. J. G. Alther. U.S.P. 2,253,007, 19.8.41. Appl. 27.10.39. Improvement in the catalytic conversion of hydrocarbon oil wherein vapours are contacted with a cracking catalyst in a reaction zone maintained at cracking temperature. Hydrocarbon oil is passed through a heating zone independent of the reaction zone, and heated to cracking temperature. The heated oil is then passed in indirect heat exchange with the vapours and catalyst in the reaction zone, and the whole separated into vaporous hydrocarbons and residue. The vaporous hydrocarbons are then introduced into the reaction zone for catalytic conversion.

C. L. Thomas. U.S.P. 2,254,553, 2.9.41. Appl. 11.1.39. Conversion of hydrocarbon oils which are heavier than gasoline by contacting the charging oil with an alumina–chromia catalyst under conditions designed to effect conversion of paraffins in the oil into normally liquid olefins. Thereafter the olefins are separated from the normally gaseous products and cracked in the presence of a silica–alumina catalyst at a temperature below the optimum cracking temperature of the charging oil. In this way lower-boiling hydrocarbons are produced from the olefins.

P. Subkow, E. W. Gard, and R. E. Haylett. U.S.P. 2,255,399, 9.9.41. Appl. 29.10.35. Conversion of hydrocarbon gases and liquids into gasoline-like fractions having high anti-knock characteristics by subjecting normally gaseous hydrocarbons to cracking conditions. Afterwards a portion of the cracked gases are subjected to higher pressures to effect polymerization of the gases. The products of polymerization are then mixed with normally liquid petroleum hydrocarbons and with the remainder of the cracked gases and the whole passed into a heated cracking and polymerization zone under substantial pressures. In this way reforming of the added hydrocarbons

and polymerization of the mixed materials are achieved. Finally the products are fractionated to yield normally liquid materials in the gasoline boiling range.

H. B. M.

Hydrogenation.

1270. Hydrogenation Patents. Standard Oil Development Co. E.P. 537,532, 25.6.41. Appl. 23.2.40. In the combined dehydrogenation and cyclization of hydrocarbons a catalyst is used consisting of a mixture of aluminium oxide and an oxide of a metal from the left side of Group VI of the periodic system. The catalyst is formed by co-precipitating the mixture from a common solution containing salts of these minerals, separating the co-precipitate so formed and drying.

H. E. Potts. E.P. 538,225, 25.7.41. Appl. 6.11.39. Preparation of an iron catalyst suitable for use in the high-pressure hydrogenation of oils in the liquid phase. Compact iron is treated with oxidizing gases at high temperatures and for a length of time sufficient substantially completely to convert the iron into iron oxide, without melting of the iron of the iron oxide formed. Thereafter the iron oxide so formed is reduced to metal by treatment with gases.

C. L. Thomas. U.S.P. 2,254,555, 2.9.41. Appl. 9.2.39. Method of treating paraffinic gasoline fractions which includes contacting it with a catalyst under dehydrogenating conditions. In this way the oil is converted predominantly into an olefinic product, which is afterwards subjected to cracking in the presence of a catalyst of different composition from the dehydrogenating catalyst, and which is selective in the breaking of carbon-to-carbon bonds.

W. A. Yarnall. U.S.P. 2,257,082, 23.9.41. Appl. 18.3.39. Dehydrogenation of normally gaseous hydrocarbons of 2 to 4 carbon atoms and low-boiling normally liquid hydrocarbons, to form olefins. The hydrocarbons are contacted at low pressures and at temperatures between 350° and 600° C., in vapour phase and in the presence of a substantial amount of carbon monoxide, with a mixture of catalysts. These catalysts include a dehydrogenating catalyst consisting of aluminium and chromium oxides, and a catalyst strongly promoting the interaction of carbon monoxide and hydrogen, consisting of the oxides of cobalt, magnesium, and thorium. H. B. M.

Polymerization and Alkylation.

1271.* Finish Year's Operation of New Type of Polymerization Unit. J. D. Waddell. *Oil Gas J.*, 28.8.41, **40** (16), 45).—The first catalytic polymerization unit licensed by the Polymerisation Process Corporation to be built in a Mid-Continent refinery recently completed its first year of operation. The relatively low investment incurred in assembling the equipment as a result of utilizing discarded cracking chambers as catalyst drums, and the subsequent favourable operating results might make this installation interesting to refiners generally.

The unit includes essentially four catalyst drums, a heater, a fractionator, pump-house, and a centralized control panel. The normal daily charge is 1500 brl., consisting of 90% C_3 and C_4 hydrocarbons, contains about 30% unsaturates, and is free of pentanes and heavier hydrocarbons. The vapours of the liquid charge preheated to about 410° F. enter the first of the series of four catalyst drums, an inlet pressure of 900 lb./sq. in. being maintained on the hot gases. These gases leave the drums at pressures ranging from 700–750 lb./sq. in.

The stream is then cooled to 200° F. and enters the plant stabilizer operating at a pressure of 200 lb./sq. in., a top temperature of 175° F., and a reboiler temperature about 385° F. The polymer product is inhibited as it leaves the cooler for storage. It usually has an end-point of 430° F., gravity 65° A.P.I., O.N. about 83·5 A.S.T.M., or 95/96 by 1939 Research Method.

The catalyst consists of copper pyrophosphate in pelleted form, and is mixed with charcoal in the proper proportions.

Arrangements are made to bypass an exhausted catalyst drum to enable it to be flushed and cooled for the removal of the spent material. D. L. S.

1272. Polymerization and Alkylation Patents. Standard Oil Development Co. E.P. 537,589, 27.6.41. Appl. 18.4.40. Process for the production of normally liquid hydrocarbons substantially completely saturated in character. A mixture containing at least one paraffinic hydrocarbon and olefinic hydrocarbons is reacted in the presence of fluorsulphonic acid. It is claimed that many of the disadvantages attaching to the use of sulphuric acid in the process of alkylation are overcome by substitution of fluorsulphonic acid.

Standard Oil Co. E.P. 537,705, 3.7.41. Appl., 19.10.39. Improved method of catalytically converting normal paraffins in a hydrocarbon mixture containing aromatics into isomeric saturated branched-chain hydrocarbons. The aromatics are removed from the hydrocarbon mixture prior to conversion of the normal paraffins.

Dow Chemical Co. E.P. 537,894, 11.7.41. Appl. 10.1.40. Process for preparing monoalkyl benzenes by reactions of olefins with benzene in the presence of an alkylation catalyst of the Friedel–Crafts type. The alkylating agent is contacted in successive stages with reaction liquors, each of which comprises an aromatic compound and a Friedel–Crafts catalyst. Aromatic compound and fresh catalyst are continuously introduced into the reaction liquor of the last stage which the alkylating agent contacts. At least a portion of the reaction liquor from each stage except the first is withdrawn and introduced into the preceding stage. Reaction liquor and suspended catalyst are continuously withdrawn from the first stage which the alkylating agent contacts, and a large part of the suspended catalyst so withdrawn returned to the first stage for re-use. The desired alkylated product is separated from the remainder of the withdrawn reaction liquor.

Standard Oil Development Co. E.P. 538,307, 29.7.41. Appl. 19.1.40. Production of normally liquid saturated hydrocarbons boiling within the gasoline range from normally gaseous saturated hydrocarbons containing at least one tertiary carbon atom and normally gaseous mono-olefins. The invention also includes similar alkylation of paraffinic hydrocarbons containing at least one tertiary carbon atom with mono-olefins, either or both components having up to six carbon atoms.

G. A. Boyd and C. H. Seeley. U.S.P. 2,253,607, 26.8.41. Appl. 19.6.37. Preparation of high anti-knock motor fuel by subjecting substantially sulphur-free gaseous hydrocarbons to controlled oxidation by contacting with steam and a nickel catalyst at 1200–1500° F. Carbon monoxide and hydrogen thus produced are mixed with substantially unpolymerizable hydrocarbons and the mixture subjected to hydrocarbon synthesis. From the synthesized hydrocarbon gases a fraction is separated containing substantially unpolymerizable fixed gases, and the fixed gases recycled to the aforesaid controlled oxidation to produce additional carbon monoxide and hydrogen. A second fraction containing polymerizable gaseous hydrocarbons is then polymerized to form hydrocarbons boiling within the motor-fuel boiling range. The polymerization product is then fractionated to recover at least one fraction comprising unpolymerized hydrocarbons and the carbon monoxide and hydrogen resulting from oxidation admixed with it. The mixture is then passed to the hydrocarbon synthesis process.

C. G. Gerhold. U.S.P. 2,254,522, 2.9.41. Appl. 8.3.39. Improved method of polymerizing olefins in the presence of sulphuric acid at polymerizing temperatures above atmospheric. In this way there is formed a polymer liquid containing sulphuric acid esters. The polymer liquid is then boiled to vaporize the lighter components. The improvement lies in supplying the heat for this boiling by direct introduction of steam to the liquid, thus preventing decomposition of the esters. The liquid is then treated with additional steam in the presence of alkali to hydrolyse and separate the esters.

H. J. Welge. U.S.P. 2,255,302, 9.9.41. Appl. 30.8.38. Polymerization of mono-olefins by subjecting a mono-olefin in gaseous state to contact with a catalyst consisting of a bisulphate of an alkali metal in solid form. The reaction is carried out at a temperature between approximately 100° C. and the melting point of the bisulphate, and in the presence of water vapour in sufficiently small proportion to avoid substantially the presence of free water in liquid state at that temperature.

D. R. Carmody. U.S.P. 2,255,843, 16.9.41. Appl. 7.12.39. Production of a high-octane-number fuel by contacting a branched-chain paraffinic hydrocarbon with methyl chloride in the presence of a metallic halide alkylation catalyst under conditions adapted to promote alkylation of the branched-chain paraffinic hydrocarbon with the organic radical of the methyl chloride.

A. R. Goldsby, E. F. Pevere, L. A. Clarke, and G. B. Hatch. U.S.P. 2,256,450, 16.9.41. Appl. 18.6.38. Alkylation of *iso*paraffins by treating olefins and an excess of low-boiling *iso*paraffins with strong sulphuric acid. In this way the *iso*paraffins are alkylated by the olefins. Afterwards the used acid is separated from the reaction products and at least part of it contacted with substantially olefin-free *iso*paraffins to strip the acid of absorbed olefins. The mixture of *iso*paraffins and hydrocarbons stripped from the acid is then passed to the alkylation operation.

A. R. Goldsby and J. C. Van Gundy. U.S.P. 2,256,880, 23.9.41. Appl. 20.4.40. Process for the continuous alkylation of *iso*paraffin hydrocarbons with olefin hydrocarbons by contacting with a liquid alkylation catalyst. Stages in the process consist in continuously passing a hydrocarbon feed containing *iso*butane, normal butane, and olefins to a series of reaction chambers, wherein the hydrocarbons are contacted with the catalyst to form alkylated hydrocarbons. The reaction mixture is continuously withdrawn from each stage and separated into a normally gaseous hydrocarbon phase rich in *iso*butane, a normally liquid hydrocarbon phase containing normal paraffins, and a catalyst phase. The normally liquid hydrocarbon phase is withdrawn and the catalyst phase returned to the stage from which it was withdrawn. The gaseous hydrocarbon phase is returned to the reaction for further contact with olefin hydrocarbons. Finally at least part of the normally liquid hydrocarbon phase is discharged and the remainder passed to the stage preceding that from which it was withdrawn.

H. B. M.

Refining and Refinery Plant.

1273.* Refining Pennsylvanian Oils with Furfural. F. T. Mertens. *Oil Gas J.*, 7.10.1940, **39** (26), 47).—A description is given of the plant and process used for the solvent extraction of Pennsylvanian oils with furfural at two refineries in Pennsylvania, with details of the products obtained. The conventional method of processing involves dewaxing of the wax distillate and reduction to neutral oil, followed by clay treatment, and clay treatment of the cylinder stock bottoms followed by centrifuge dewaxing and removal of dilution naphtha. With furfural refining the crude charge is split into the same two products; if no solvent dewaxing is to be carried out, the solvent extraction preceding the reduction and clay treatment of the wax distillate, and being the first stage of the cylinder stock treatment. If solvent dewaxing is carried out after solvent extraction, the crude charge is distilled to a higher viscosity distillate, giving the neutral oil on finishing. A typical treatment consists of preheating to 140–180° F. and charging to the middle of the vertical counterflow extraction tower, at the top of which furfural at 200–280° F. is introduced. The refined oil solution is removed from the top of the tower, heat exchanged, and stripped in a vacuum flash and stripping tower. Extract and solvent from the base of the tower are flashed in an atmospheric column which removes 30–40% of the solvent, and then in a pressure-flash section, followed by a vacuum steam stripper. Furfural is removed from condensate water by taking advantage of the formation of a constant-boiling mixture with water.

A yield of 90·1% of raffinate of 101·5 V.I. is obtained from zero pour point 94·4 V.I. dewaxed Penna 600 stock, and of 89·8% of raffinate of 109·6 V.I. from — 10° F. pour point 93·5 V.I. Penna Neutral. Furfural refining is claimed to improve the stability and sludging tendency of these oils, and has reduced percolation filter costs by increasing the filter yields from 50% to over 300%.

C. L. G.

1274.* (Shell Operating) First Solutizer Treating Plant at Wood River. L. E. Border. *Oil Gas J.*, 7.11.40, **39** (26), 55.—A description is given of the operation of the first solutizer treating plant at a Wood River Refinery. The plant has a capacity of 15,000 brl. per day handling a blend of straight-run, cracked, and reformed gasoline. The solutizer used is composed of 6N-KOH, plus 3N-potassium *iso*butyrate, and is

prepared by neutralizing with isobutyric acid one-third of the KOH in a 9N-KOH solution. The plant consists of an extraction section and a regenerating section (flow-sheet given). Gasoline cooled to 85° F. is passed to the foot of the 58-ft. extraction tower which contains a 30-ft. section of carbon-ring packing and baffles. The sweetened gasoline from the top of the tower contains 0·02% of solutizer solution, 90% of which is removed in a settler and the balance in a steel-wool coalescer, no further treatment being required. The spent solution contains 1% of suspended and 0·5% of dissolved gasoline, the latter being liberated on dilution with stripped aqueous condensate from the regenerator. The diluted solution is heated to 255° F. and passed to the stripping column, where part of the mercaptan removal takes place, the remainder being removed in the reboiler. The solutizer treatment reduces the mercaptan sulphur and total sulphur from 0·09% and 0·12%, respectively, to 0·0004% and 0·03% respectively, the octane number being increased from 69·5 to 70.

The untreated gasoline requires 0·65 and 2·20 c.c. of T.E.L. per gallon to increase the O.N. to 75 and 80, respectively, whereas the treated gasoline only requires 0·38 and 1·30 c.c., respectively. An overall saving of 5 c. per brl. over conventional doctor treatment is claimed. C. L. G.

1275.* Refining Characteristics of Mississippi Crude. D. Read, Jr., and G. Egloff. *Oil Gas J.*, 31.7.41, **40** (12), 148.—The Tinsley field of Yazoo County, Miss., now ranks among the major oil-fields. The reserve pressure in the field is relatively low in all sands, and approximately half the 200 wells at present in production are on artificial lift, but this does not greatly affect the recoverable reserve estimate.

At the moment approximately 62% of production moves to Louisiana for transhipment and refining, 15·5% goes to Illinois, direct shipments to Kentucky and Tennessee refiners account for 9 and 5%, respectively, whilst about 8·5% is refined within the State.

A 34·2° A.P.I. gravity representative sample of this crude was distilled in a 10-in. laboratory Hempel column to produce 15% gasoline, 10% naphtha, 12% kerosine, 8% diesel fuel, 40% heavy gas-oil, and 15% asphalt bottoms. In additional break-ups the crude was fractionated to produce 400° F. end-point gasoline, 525° F. end-point kerosine, and topped and reduced crudes.

Both a 40% gas-oil fraction and a 25·4° A.P.I. topped crude were thermally cracked to determine the yield and quality of the products obtainable.

Tinsley crude is similar to Mid-Continent material in gasoline content and gravity. Detailed properties of the crude and laboratory distillation analyses are given in tables included in the paper. Although the sulphur content of the crude is 0·79%, the light straight-run fractions were each sweet, and contained only small amounts of sulphur. The distillate fractions were high in paraffinic compounds, as shown by low specific gravities and relatively low octane numbers. The crude yielded 27·6% of 390 O.N. 400° F. end-point gasoline or 14·9% 52·5 O.N. spirit, indicating that the light gasolines would be unsuitable as aviation base stock. The kerosine was of good quality, whilst the diesel fuel (cetane number 57) would be satisfactory for high-speed engines. The asphalt bottoms after removal of the 40% gas-oil fraction had a penetration at 77° F. of 40.

As a result of cracking the gas-oil fraction 58·6% of 68 O.N. gasoline was produced, as against 50–53% when using a topped crude. The sweetened gasoline from the gas-oil cracking gave an O.N. of 77·5 by the addition of 3 c.c. T.E.L. per gallon, whilst that obtained from the topped crude gave under the same conditions a 75·5 O.N. product. C. L. G.

1276.* Greatly Improve Lead Response by Desulphurizing Gasoline. W. T. Ziegenhain. *Oil Gas J.*, 28.8.41, **40** (16), 42.—The octane value of the straight-run gasoline produced in the 2000-brl. plant of Malco Refineries, Inc., located at Artesia, N.M., has been greatly improved by the recent installation of desulphurizing equipment.

The plant processes crude from the Artesia and Maljamar fields, and the gasoline was formerly sold as third-grade motor fuel. By treatment using the Perco catalytic desulphurization process, the sulphur content of the gasoline has been reduced by 95%, its O.N. increased by about 3 units and with 1 c.c. of T.E.L. by about 7 units. With higher additions of lead the improvement is even more marked.

When base-stock for ethyl gasoline is required, about 10% butane-free natural

gasoline is added to the feed-stock to be treated, and a fuel is obtained which, with slightly less than 2 c.c. T.E.L., has O.N. of 80.

The paper includes a simplified flow-sheet and a brief description of the process.

D. L. S.

1277.* Refinery Piping—Providing for Expansion in Hot Lines. R. G. Lovell. *Petrol. Engr*, July 1941, **12** (11), 27.—A general analysis from a practical viewpoint of the problem of providing for expansion in refinery hot pipe-lines. A curve of the linear expansion of steel pipe against temperature is shown, and a discussion is included of bursting stress, creep, and plastic flow. Various expedients, such as pipe-bends and expansion joints for above-ground pipe-lines, are described. The theory of expansion phenomena for underground pipe-lines is considered incomplete and a new theory is developed to agree with practice. The protection of valves by concrete anchors and means for obtaining leak-free threaded joints, with a table for determining thread specifications, are given.

J. C.

1278.* Submerged Coolers for Refinery Service. D. E. Fields. *Petrol. Engr*, 1941, **12** (12), 98.—With tubular condenser banks of the usual construction, the removal of tubes which require replacement is an operation which demands a considerable amount of end-space, and entails lifting the entire bank of tubes from the condenser box.

The form of construction here described makes it practicable to remove any tube or all the tubes from the bank without removing the latter from the box, provided about 2 ft. of space is available between the cooler and the sides of the box. The tubes are supported at either end by means of two tube-sheets, the intermediate support being given by horizontal rollers. U-shaped spacers are slipped over alternate vertical rows of tubes, straddling the rollers, the spacers and rollers being locked in position.

The tubes are readily removed by unlocking and removing the spacers and rollers, and withdrawing the tubes through the side of the bank, "springing" them out of the end tube-sheets.

C. G. G.

1279.* Rerun Unit Designed to Operate with Heating Medium and Exchangers. Anon. *Refiner*, September 1941, **20** (9), 386–389.—A departure from the conventional distillation practice is in the method of evaporation. Instead of charging the distillate to direct-fired tube-stills, an enclosed system was developed through which a separate heating medium is circulated at controlled temperature and volume, using shell-and-tube exchangers in conjunction with the heat medium circuit, and fractionating column to evaporate the pressure distillate.

The fractionating tower was designed especially for re-running the pressure distillate. It is 13 ft. in diameter and 48 ft. 6 ins. high, equipped with twelve fractionating bubble trays and six stripping plates, all of which are installed on 24-in. spacing, and has clean-out manholes at each tray. The 18-in. vapour line at the overhead outlet is flanged directly to a shell-and-tube vapour-to-charge exchanger which contains 1720 sq. ft. of tube surface. Two heat medium exchangers heat the feed to the column, the first having 710 sq. ft. and the second 1500 sq. ft. of tube surface. The second exchanger is located in a vertical position close to the tower, with a single pass through the tubes to permit of nearly complete vaporization of the feed without excessive pressure drop.

The heat medium is a 32–33° A.P.I. gas oil, which is picked up from a 9 ft. × 12 ft. horizontal surge-tank by a steam-turbine-driven centrifugal pump, and discharged with a pump pressure of 60 lbs./sq. in. to direct-fired tube-stills in which about 40,000,000 B.t.u./hr. are liberated. The outlet or transfer line of the heat medium heater is maintained at 610° F. and the pressure of 48 lb./sq. in. to the various exchangers included in the heating circuit.

Laboratory as well as operational data are included in the description of the operation of the plant.

A. H. N.

1280.* Combination Charging Stock Yields High Octane and Extended Run. Anon. *Refiner*, October 1941, **20** (10), 411–412.—Through an uninterrupted run of 2561 hr.

one refinery obtained an overall liquid yield of 94·45%. In this yield was 60·85% overhead distillate, which was fractionated to an end-point of 395° F., having a gravity of 61·7° A.P.I. The octane value of this product was 68, research method, which, with the addition on 1 c.c. T.E.L., was raised to an octane value of 75.5. The charge to the fractionating tower during this 106-day run consisted of a mixture of reduced crude and fresh crude.

This plant was built as a straight skimming plant. A single-furnace Dubbs cracking unit built in 1939 had a capacity of 1000 brl./day, to operate as a full flashing, selective cracking unit. In 1940 the plant was increased to its present capacity of 2000 brl. by adding a second furnace and the necessary pumps and instruments for adequate operation and control. Certain details of the plant are described.

A. H. N.

1281.* **Qualified Welding in Refining.** W. L. Archer. *Refiner*, October 1941, **20** (10), 413–416.—To-day welding is being performed in conformance with rules and regulations of apparently haphazard nature but of real importance and significance. The paper deals with each factor separately, explaining their significances. The subjects discussed cover process, base metal, filler metal, position, preparation of base material, nature of electric current, size of welding tip, nature of flame, method of welding (backhand or forehand), welding technique, cleaning, defects, peening, treatment of underside of welding groove, preheating, heat treatment, and tests required.

The paper is the first of a series on welding.

A. H. N.

1282.* **Steam Generating Unit Also Improves Fractionation and Condensation.** Anon. *Refiner*, October 1941, **20** (10), 417–418.—By installing equipment for generating steam by heat exchange with streams of flash-chamber and the main fractionating column, one company has augmented its boiler-feed as well as improved operation of the fractionating column. Before being returned to the column for reflux the light oil-stream operates in steam generation, with the result that a smaller quantity is required for maintaining the proper top temperature for the column. The heat reduction in the residuum stream from the flash-chamber is reduced by 300° F. in its heat exchange, with the result that less water is used for condensation.

The steam generating unit produces an average of 4500 lb. of steam/hr. at 125 lb./sq. in.

Residuum from the flash-chamber is withdrawn at 805° F., which in conventional operation is water-cooled to required storage temperature. In the main fractionating chamber the light oil-stream has a temperature of 560° F. Taking advantage of the temperature of both streams, facilities were recently installed for steam generation. The details are given briefly.

A. H. N.

1283*. **Caustic-Methanol Mercaptan Extraction Process.** F. W. Field. *Refiner*, October 1941, **20** (10), 419–420.—A radically new refining process, developed by the Atlantic Refining Co., removes mercaptans from gasoline and substantially improves its lead susceptibility. Octane rating suffers no loss in any gasoline treated by this process, and in many gasolines is increased.

Mercaptan removal is brought about by extraction with an aqueous solution of caustic soda and methanol. The caustic is continuously regenerated, and the methanol almost entirely recovered. The process is based on existing patents and a considerable number of recent applications.

The tetraethyl lead saving caused by the elimination of octane loss, and the increase in lead susceptibility produced by caustic-methanol extraction, will usually pay all costs of operating the process, and in some instances yield a profit.

Advantage can be taken of the higher finished octane and lower sulphur content obtainable by caustic-methanol extraction in any of three ways: (1) By using less tetraethyl lead and selling a product of the same quality as before installation of the process. (2) By using approximately the same amount of lead and selling a better product. (3) By using a higher proportion of sour crudes. If a product of the same octane rating as before the installation of caustic-methanol treating is marketed, the lead savings are substantial. Few gasolines will show a saving of less than 0·25 c.c. tetraethyl lead/gal., whilst in some the savings run to as high as 1·0 c.c.

The flow of the process is described. Laboratory test results are given to substantiate the claims made with regard to the octane rating and response of treated gasolines. A. H. N.

1284.* Skimming Heat from Cracking Unit. Anon. *Refiner*, October 1941, **20** (10), 425–426.—The skimming side of the refinery is separate from the cracking section, but dependent on it for heat. Instead of a skimming pipe still, as in conventional plants, the crude passes through several exchangers and two salt-settling drums before it is flashed to one of two bubble towers for the manufacture of straight-run gasoline. The first bubble tower in the skimming section removes only straight-run gasoline, whilst the second tower is restricted to naphtha, kerosine, diesel-fuel distillate, and topped crude.

The fresh crude is pumped through an exchanger on the kerosine stream and passes through the second bubble tower overhead vapour exchanger to the first salt-settling drum. Without further application of heat, the charge enters the second salt drum, and from this vessel exchanges heat with overhead vapours from the cracking plant first fractionating column, and goes to the first bubble tower of the skimming section. Gasoline is produced and fractionated to end-point with condensate pumped back over the top, and, to increase the recovery of this material, the bubble tower is equipped with a base heater, or reboiler, the heat of which is obtained from the cracking plant residuum exchanger and products cooler.

The cracking plant is next described with some detail of the operations.

A. H. N.

1285. Patents on Refining and Refinery Plant. Standard Oil Development Co. E.P. 538,697, 13.8.41. Appl. 25.4.40. Method of carrying out catalytic reactions involving periodic regeneration of the catalyst. The invention is particularly adapted to the catalytic treatment of hydrocarbon oils such as cracking, purifying, and refining in the presence of a solid contact mass.

Standard Oil Development Co. E.P. 538,747, 14.8.41. Appl. 12.8.40. Improved process and apparatus for dewaxing petroleum distillates by means of which it is possible to secure optimum heat transfer and hence improved operating efficiency. The waxy distillate is chilled by the vaporization of a refrigerant therefrom. Thereafter waxy constituents are removed from the chilled oil and the dewaxed oil contacted with the vaporized refrigerant to condense it.

W. Mendius. U.S.P. 2,252,020, 12.8.41. Appl. 11.5.38. Improvement in the fractionation of petroleum stocks by means of towers into which a stream of the stock is discharged after being heated to vaporize a substantial part thereof. A liquefied fraction which has been withdrawn from the tower is reintroduced at a point below that at which it was withdrawn. The fraction being cooled is passed in indirect heat exchange with the vapours and liquids flowing through the tower in a region below the point at which it is reintroduced.

F. L. McKennon. U.S.P. 2,253,638, 26.8.41. Appl. 15.12.39. Method of removing acid reacting materials from a hydrocarbon liquid by treating with an aqueous solution of a strong base containing a substantial amount of an urea dissolved in it. Conditions are adjusted to effect extraction of the acid reacting materials from the hydrocarbon liquid and leave it substantially free of undesirable acid reacting materials.

P. J. Gaylor. U.S.P. 2,254,364, 2.9.41. Appl. 9.6.38. Method of treating petroleum oil by contacting it with a normally solid aromatic ester of a phthalic acid at a temperature below the complete miscibility temperature of the oil and the solvent, but above that at which the solvent solidifies. After such treatment the raffinate and solvent extract phases are separated.

E. J. Houdry. U.S.P. 2,255,060, 9.9.41. Appl. 2.8.39. Process for producing clean distillate stock from liquid or liquifiable hydrocarbons. The hydrocarbon charge is heated to at least 800° F. to provide a mixture of vaporized and unvaporized material, which is subsequently fed to an enlarged coking zone. A vaporizing medium is used to minimize formation of material within the gasoline boiling range. The

liquid material in the coking zone is agitated by feeding at least part of the fluids entering the zone to the lowest part. In order to effect rapid decomposition of the liquid material into vaporized material and coke, the whole of the coking zone is maintained at a temperature above 800° F. The rate of feed to the coking zone is controlled in such a way that vaporized material remains there for less than 50 sec. Production of material in the gasoline boiling range is limited to not more than 5% by weight of the hydrocarbon charge.

H. O. Forrest. U.S.P. 2,255,283, 9.9.41. Appl. 21.11.38. Method of refining a heavy petroleum oil to produce lubricating oil. A residual lubricating-oil stock containing uncracked heavy components and resins is fractionated into at least one viscous oil fraction having a viscosity at 210° F. below 300 sec. Saybolt and a resin fraction having a viscosity at 210° F. of more than 300 sec. Saybolt. The resin fraction is then diluted with a hydrocarbon diluent heavier than propane, but lighter than the removed viscous oil fraction. The diluted resin fraction is contacted with clay in the absence of the separated viscous oil fraction and the latter separately treated to improve its colour and quality. Finally, at least a portion of the clay-contacted resin fraction is blended with the treated viscous oil fraction to improve the quality of the viscous fraction.

W. A. Schulze. U.S.P. 2,255,394, 9.9.41. Appl. 9.11.38.—Production of sweet motor fuel from crude petroleum oil by first subjecting it to a medium-temperature flashing operation to produce stabilized crude oil and a low-boiling straight-run gasoline; then subjecting the stabilized crude oil to distillation to produce straight-run gasoline and topped crude; subjecting the topped crude to cracking to produce a gaseous fraction containing some gasoline hydrocarbons and a fraction consisting of cracked gasoline; processing the gaseous fraction to recover the gasoline content, and separating the cracked gasoline into a low-boiling fraction containing seven and less carbon atoms per molecule and a higher-boiling fraction containing more than seven carbon atoms per molecule. The improvement lies in sweetening the cracked gasoline fraction containing more than seven carbon atoms per molecule by treating with a cupric chloride solution, followed by sodium sulphide stabilization. The remainder of the gasoline fractions are sweetened by passage with dissolved air over a solid adsorbent reagent impregnated with a solution of cupric chloride.

C. Ellis, T. C. Whitner and W. V. Keegan. U.S.P. 2,255,417, 9.9.41. Appl. 3.12.38. Method of sweetening sour petroleum oil containing mercaptans by converting the latter into oil-soluble mercaptides of a heavy metal. Afterwards the oil containing the mercaptides in liquid phase is treated with a salt of a halogenated monocarboxylic acid and the salt reacted with the mercaptides to form oil-soluble derivatives which can subsequently be removed from the oil.

W. A. McMillan. U.S.P. 2,256,405, 16.9.41. Appl. 5.12.39. Process of recovering normally gaseous petroleum hydrocarbons, including propane, from a gas mixture. The hydrocarbons are continuously absorbed in an absorbing oil to produce an enriched oil, which is then passed to a still and subjected to distillation to remove absorbed hydrocarbons. The oil from which the hydrocarbons have been removed is withdrawn and a liquefied fraction consisting predominantly of propane segregated from the removed absorbed hydrocarbons. At least a portion of the absorbed oil is mixed with the segregated fraction in an amount sufficient to precipitate tarry constituents. The mixture is maintained at a temperature substantially above atmospheric and the resulting precipitate removed. The remaining solution of purified absorption oil is mixed with the enriched oil passing to the still, and the mixture subjected to distillation to effect simultaneous vaporization of normally gaseous hydrocarbons from both the purified oil and the enriched oil. The lean oil, including that from which the tarry constituents have been removed, is returned to the absorption cycle.

G. W. Duncan. U.S.P. 2,257,547, 30.9.41. Appl. 17.3.39. Process for the solvent treatment of mineral oils which comprises contacting a petroleum lubricating oil in a counter-current treating system with phenol at a temperature between 90° and 250° F., and under conditions designed to form a solvent extract phase and a raffinate phase. The solvent extract phase is separated and extract oil recovered therefrom.

5–20% of water is added to the raffinate phase at a temperature at which the raffinate phase separates from a phenol–water phase. The raffinate oil is separated and the phenol completely removed from it. The phenol–water phase is then separated and returned to the counter-current treating system at a plurality of stages between the point of introduction of the oil-feed and the point at which the raffinate phase is withdrawn. H. B. M.

Chemistry and Physics of Petroleum.

1286.* Measurement of Flame Gas Temperatures. W. T. David. *Engineer*, **172**, 4471, 186–187.—The author discusses the agreement which may be expected between the measured temperatures by well-known methods and the ideally calculated temperatures of combustible gas–air mixtures.

The accuracy of the sodium-line reversal method is shown to be susceptible to the degree of mixing and to the effects of sodium salts present in the mixture.

Flame-gas temperature measurements carried out with platinum and platinum–rhodium wires showed that provided the wire is quartz-covered, substantially correct results can be expected when measuring temperatures of flame gases resulting from the combustion of carbon monoxide–air and hydrogen–air mixtures. E. F. C.

1287.* Thermal Conductivity of Twelve Industrial Chlorinated Hydrocarbons. O. K. Bates, G. Hazzard, and G. Palmer, *Industr. Engng Chem.*, 1941, **33** (3), 375.—The thermal conductivity and temperature coefficients of conductivity are given for methylene chloride, chloroform, carbontetrachloride, dichloroethylene Di-48, dichloroethylene Di-60, β-trichloroethylene, tetrachloroethylene, ethylene dichloride, trichloroethane, tetrachloroethane, pentachloroethane, and propylene dichloride. J. W. H.

1288.* Diffusion, Thermal Conductivity and Viscous Flow. R. E. Powell, W. E. Roseveare, and H. Eyring. *Industr. Engng Chem.*, 1941, **33** (4), 430.—A general theory of viscosity, diffusion, thermal conductivity, and ionic conductivity is developed in terms of the statistical mechanical theory of reaction rate. These properties are shown to be quantitatively expressed by equations which are in terms of measurable thermodynamic properties. These equations include the case of the interdiffusion of molecules of different sizes. J. W. H.

1289.* Heat and Vapour Transfer in a Wetted-wall Tower. W. A. Barnet and K. A. Kobe. *Industr. Engng. Chem.*, 1941, **33** (4), 436.—Heat-transfer data were obtained from the operation of a wetted-wall tower with countercurrent flow of a mineral oil and air. Simultaneous heat and vapour transfer data were obtained by operation with air and water. The results of these experiments showed that in all cases the gas film controlled the rate of heat transfer, whether or not simultaneous vapour transfer occurred. The data are correlated by the Nusselt, the Chilton–Colburn, and the Arnold theories. The Arnold and Colburn theories are better correlation between heat and vapour transfer than the Nusselt theory. The heat-transfer coefficients for direct contact with gas and liquid, as determined in this investigation, are considerably larger than those normally obtained when the fluids are separated by a metal wall; for which reason heat transfer between gas and liquid should be carried out whenever possible by direct contact. J. W. H.

1290.* Simplified Calculation of Diffusional Processes. A. P. Colburn. *Industr. Engng Chem.*, 1941, **33** (4), 459.—Equations are derived which, when represented graphically, enable the number of theoretical plates required for a given separation to be calculated with an accuracy of 2–9% for absorption, distillation, and counter-current liquid–liquid extraction processes. The simple equations are extended to apply to cases when there is curvature in the operating or equilibrium lines or both. Four examples are given showing the method of evaluating the number of transfer units and theoretical plates required for a given separation. J. W. H.

1291.* Calculation of the Effect of Reflux Ratio in Batch Fractionation. A. Rose and H. H. Long. *Industr. Engng Chem.*, 1941, **33** (5), 684.—This paper summarizes

the results obtained by calculation of the effects of reflux ratio on the distillation curves of binary mixtures for different values of vapour-pressure ratio (α) and the number of plates (n). The principal conclusions are as follows:

1. The magnitude of the effect of reflux ration (R) depends, in order of importance, on α, R, and n.
2. The effect of increasing R is proportionately greater for a small value of R and for given values of α and n, and in many cases there is an insignificant increase in the sharpness of separation for increased values of R beyond a certain point.
3. Where α is small, R has little effect on the sharpness of separation, unless n is large.

J. W. H.

1292.* Calculation of Theoretical Plates Required for Separation of Two Normal Liquids by Batch Fractionation. A. Rose. *Industr. Engng Chem.*, 1941, **33** (5), 594.—Equations and graphs are given for the estimation of the number of theoretical plates (n) at minimum, optimum and maximum reflux ratio (R) required for a standard separation of two similar normal liquids with normal vapour–liquid equilibrium relationships and in cases when the usual simplifying assumptions of distillation and negligible hold-up are justified. The separation selected is that the first 40% distillate, 50-50 mixture is to have an average purity of 95 mol.-%. For optimum conditions

$$n = \frac{2{\cdot}85}{\mathrm{Log}_{10}\,\alpha} = R$$

in which α is the vapour-pressure ratio of the two components undergoing separation.

J. W. H.

1293.* Design of Fractionating Columns for Very Dilute Solutions. Tzeng-Jiueq Suen. *Industr. Engng Chem.*, 1941, **33** (5), 656.—When the concentration of one of the components of a binary mixture is very low, the construction of a McCabe and Thiele diagram is laborious, due to the large number of steps required at the ends of the separation. For very dilute solutions it is shown that the vapour–liquid equilibrium is practically linear and the use of an algebraic method based on this property, analogous to the Browns absorption factor, is explained. J. W. H.

1294.* Nomographs for Thermal Conductivity of Gases and Vapours. D. S. Davis. *Industr. Engng Chem.*, 1941, **33** (5), 675.—Three nomographs are presented illustrating the conductivity–temperature relationships of some thirty-two substances, including ten hydrocarbons. In addition a nomograph is given relating H_2 with conductivity for mixtures of H_2, CO_2, N_2O, and N_2 at 32° F. J. W. H.

1295. Petroleum Bases. II. Amino- and Hydroxy-Derivatives and a Contribution to the Chemistry of Diazo-Oxides. L. R. Modlin, Jr., and A. Burger. *J. Amer. chem. Soc.*, 1941, **63**, 1115–1118.—This paper gives an account of the preparation of various amino- and hydroxy-derivatives from the kerosine base, 2 : 3 : 8-trimethylquinoline. The conversion of 2 : 3 : 8-trimethylquinoline-6-diazo-5-oxide into 2 : 3 : 8-trimethylquinoline-5 : 6-quinonedioxime by means of hydroxylamine represents a reaction hitherto unknown for *o*-diazo-oxides. R. D. S.

1296. Polymerization of Olefins. III. Polymeric Olefins from Methyl*iso*propylcarbinol. F. C. Whitmore and W. A. Mosher. *J. Amer. chem. Soc.*, 1941, **63**, 1120–1123.—The authors studied all the products of the reaction of 75% sulphuric acid with methyl*iso*propylcarbinol at 80° C. and, incidentally, confirmed the findings of Drake, Kline, and Rose (*J. Amer. chem. Soc.*, 1934, **56**, 2076), who found only two decenes: 3 : 4 : 5 : 5-tetramethyl-2-hexene (A) and 3 : 5 : 5-trimethyl-2-heptene (B), among the products of reaction. The following is a complete list of the products identified, together with their yields. Trimethylethylene, 1%; 3-methyl-2-pentene, 3%; methyl*iso*propyl ketone, 1%; di*iso*butylenes, 1%; 2 : 3 : 4 : 4-tetramethyl-1-pentene,

2%; other nonenes, 1%; decene (A), 45%; decene (B), 35%; higher polymers, 5%; intermediates, 5%. The authors synthesized 3 : 5 : 5-trimethyl-3-heptanol by the action of ethyl magnesium bromide on 4 : 4-dimethyl-2-hexanone. It was first dehydrated with copper sulphate and, secondly, with 75% sulphuric acid at 80° C. The ratio of the resulting isomers was different in each case. The relation of this dehydration to the structure of the polymers is discussed. Ethyl Grignard reagent would not add to 3 : 4 : 4-trimethyl-2-pentanone, nor would methyl Grignard reagent add to 4 : 5 : 5-trimethyl-3-hexanone, enolization being the chief reaction in each case.
R. D. S.

1297. Chromium Oxide Gel Catalysts for Dehydrocyclization of *n*-Heptane. J. Turkevich, H. Fehrer, and H. S. Taylor. *J. Amer. chem. Soc.*, 1941, **63**, 1129–1131.—The authors prepared chromium oxide gel catalysts by the following methods, with a view to examining their characteristics in the dehydrogenation-cyclization of *n*-heptane and determining the composition of the liquid product in olefins and aromatics: (*a*) the standard gel, by slow precipitation with dilute ammonia from dilute chromium nitrate solutions; (*b*) formation from a chromium oxide jelly; (*c*) from chromic acetate; (*d*) as amorphous chromium oxide by reduction of chromic acid by alcohol and other organic reducing agents. Catalysts prepared by alcohol reduction of chromic acid were found to be highly active and readily prepared in bulk. The catalysts prepared by partial reduction of chromic acid with oxalic acid were also readily prepared, and found to possess high aromatizing activity, but only moderately active products were obtained by the reduction of chromic acid by sugar solutions. During the dehydrogenation of heptane, it was found that a fall in activity steadily occurred which reduced catalyst activity for subsequent dehydrogenations of *cyclo*hexane.
R. D. S.

1298. Thermal Stability, Poisoning, Revivification and Reactivity of Chromium Oxide Gel Catalysts for Dehydro-Cyclization. D. J. Salley, H. Fehrer, and H. S. Taylor. *J. Amer. chem. Soc.*, 1941, **63**, 1131–1133.—This paper records the characteristics of the chromium oxide gel catalysts used in the experiments reported in the previous paper. It was found that water can be desorbed from gels between 300° and 550° C. Negligible amounts of hydrogen are desorbed above 350°, but a small amount is removed between 300° and 350° C. The colour of the gel is no criterion of the harmful "glow" phenomenon, but indicates the state of oxidation of the surface; thus, black indicates an oxidized surface and green a reduced surface. During dehydrogenation and dehydrocyclization the catalyst becomes spent but can be revivified by passing oxygen–nitrogen mixtures over the surface, which is cleansed by oxidation of the carbonaceous products. Poisoning and revivification can be repeated continuously without affecting the efficiency of the catalyst. The conditions for revivification are given. Water vapour acts as a poison, temporarily retarding dehydrogenation. The gel is stable up to temperatures of 600° C. and over when properly controlled.
R. D. S.

1299. Thermal Data on Organic Compounds. XXI. Some Heat Capacity Entropy and Free Energy Data for the Four Methylnonanes. G. S. Parks, T. J. West, and G. E. Moore. *J. Amer. chem. Soc.*, 1941, **63**, 1133–1135.—The paper tabulates specific heats and corresponding heats of fusion between 80° and 298° K. The entropies in the liquid state at 298·16° K. have been calculated therefrom. In addition, the calculated free energies of 2-methyl- and 5-methyl-nonane were found to be lower than *n*-decane.
R. D. S.

1300. Determination of Critical Temperature from Index of Refraction. S. W. Wan. *J. phys. Chem.*, 1941, **45** (6), 903.—A linear relation between the critical temperature (T_c) and molecular refraction (R) of the form $T_c = K_1R + K_2$ is derived for compounds belonging to specific chemical groups. The values of the constants for hydrocarbons, alcohols, ethers, carboxylic acids, esters, and nitriles are given. The agreement between the calculated and experimental values of T_c is good. J. W. H.

1301.* Chart to Provide Approximate Correction for Temperature and Deviation from Boyle's Law. A. D. Brokaw. *Petrol. Tech.*, September 1941, A.I.M.M.E. Tech. Pub. No. 1375, 1–3.—The chart was prepared by interpolating for the desired values in the

data of Burke and Keyes, and Kvalnes and Gaddy on the compressibility of methane, after adjusting their results from 0° C. to 60° F., and combining the correction factors for compressibility and temperature into a single multiplier, which, applied to the product of pressure and reservoir volume, gives at once the volume at one atmosphere and 60° F. Correction factors or multipliers at intervals of 0·05 from 0·55 to 1·40 have been plotted.

The computation applies strictly only to pure methane, and for natural gas composed of mixed hydrocarbons the estimates will be low, because of the greater compressibility of such gases. Brown has worked out approximate corrections for mixtures of hydrocarbon gases, and a table gives the amounts to be subtracted from the pressure and temperature to change the origin of the chart to give an approximation to Brown's results when the specific gravity of the gas is known.

Two examples are worked out, and it is indicated that the accuracy of the method is higher than that likely to obtain in estimating the reservoir volume. G. D. H.

1302.* Chemical Conversions of Lighter Hydrocarbons. G. Armistead, *Jr. Refiner*, September 1941, **20** (9), 327–336.—A national emergency, with its extra demands for special synthetic fuels and numbers of other products, including pure hydrocarbons and their derivatives, increases the importance of petroleum and natural gas as a chemical raw material. As such they have advantages, including abundance and wide distribution, ease of transportation, and a make-up almost wholly of carbon and hydrogen. The most important hydrocarbons for chemical conversions so far have been the lighter ones up to the octanes (C_8), chiefly because of the type and current demand for their derivatives, the fact that many of them lie within the gasoline boiling range, and the relatively low number of isomers. The paper summarizes the various types of conversions applicable to these hydrocarbons, which now are or have prospect of being of particular commercial importance.

The processes briefly outlined under separate headings are: (1) Catalytic polymerization. (2) Thermal polymerization. (3) Gas Reversion (Polyforming). (4) Thermal alkylation. (5) Catalytic alkylation. (6) Isomerization. (7) Dehydrogenation. (8) Fischer–Tropsh process. (9) Hydroforming and other aromatization. (10) Rubber substitutes from petroleum. (11) Miscellaneous chemicals from petroleum. All these processes have the common denominator of applying to the conversion of the lighter aliphatic hydrocarbons to specific other compounds or classes of compounds by more or less clearly defined reactions.

Under "Miscellaneous Chemicals from Petroleum" come the products of cracked gases. These gases, with their substantial olefine content, are a primary source of chemicals, starting with the sulphuric acid absorption of the olefines, followed by hydrolysis and other reactions producing a variety of alcohols, ketones, ethers, and other products. Acetone is being prepared from propylene by first converting it to *iso*propyl alcohol and then dehydrogenating to acetone. Ethyl alcohol is prepared from ethylene. Amyl alcohol and its derivatives are prepared from the chlorination of pentane. By chlorination of ethylene, followed by other reactions, ethylene glycol is prepared by Carbide and Carbon Chemicals Corporation. Recently, Shell Development Co. has announced a process for making glycerine from propylene, employing a high-temperature chlorination step developed by them. A plant has recently been erected for the nitration of paraffin hydrocarbons. Shell Chemical Co. is cracking natural gas at high temperatures to separate hydrogen for subsequent use in a high-pressure ammonia synthesis. A. H. N.

1303.* Pyrolysis of Several Lower Hydrocarbons in the Presence of Methyl-Chloride. H. C. Lu and R. L. Huntington. *Refiner*, September 1941, 20 (9), 390–393.—Pyrolysis of the lower hydrocarbons in the presence of methyl chloride can be explained by the existence of free radicals. The removal of hydrogen in the form of hydrogen chloride succeeds to a certain extent in obtaining unsaturated hydrocarbons, but in order to make this process industrially feasible, further experimentation is necessary.

The present paper reports experiments with propane, ethane, and ethylene in presence of methyl chloride or natural gas, calcium phosphate being used as a catalyst.

Experimental procedure is described as well as the results obtained. Pyrolysis of methyl chloride was studied under non-catalytic conditions and also in the presence of

several types of catalysts. The products of decomposition, besides a small amount of unsaturated hydrocarbons, consist of carbon, hydrogen, hydrogen chloride, and methane.

Comparison has been made between the cracking of mixtures of methyl chloride with ethane, propane, and ethylene, and similar mixtures of natural gas in the place of methyl chloride. In these experiments a greater yield of unsaturated hydrocarbons in the cracking of CH_3Cl mixtures was noticed. By examining the results of the experiments, several possible types of reactions have been suggested for the thermal decomposition of methyl chloride.

The low yield of olefine, and the rapid decomposition of methyl chloride into carbon and hydrogen during its pyrolysis, make the process unattractive at least at the present for the purpose of obtaining unsaturated hydrocarbons from methyl chloride. A. H. N.

1304.* Action of Sulphur on Hydrocarbons Under High Pressure. W. Friedmann. *Refiner*, October 1941, **20** (10), 395–406.—From results of experiments conducted on normal heptane, *iso*-octane, and *iso*decane, the following general conclusions are reached. (1) The normal hydrocarbons change into branched systems, especially those which, under the directional influence of sulphur, tend to form a five-membered ring with sulphur in the bridge. The latter, obtained during a mild reaction, are generally regarded as thiophanes. (2) The branched hydrocarbons give simultaneously thiophanes and sulphides, CH_3–S–CH_3, which are formed when, for example, the quaternary carbon atom of the branched hydrocarbons (*iso*-octane) cause a slight disintegration of the molecule, after which the fragments of the branched molecule react with sulphur. (3) Thiophanes react further with sulphur forming: (*a*) thiophenes with partly dehydrogenated products as intermediate compounds, from normal paraffins; (*b*) thiophthenes (probably thiophthanes, also) from normal heptane and from normal octane; (*c*) polythiophanes or thiophane polysulphides, from *iso*-octane; (*d*) dithienyls (probably hydrogenated dithienyls as an intermediary product) from *iso*decane. Experimental data are given under separate sections dealing with the three hydrocarbons studied.

It is argued that it is a mistake to regard a certain predetermined sulphur content in an oil fraction as detrimental and demanding its complete removal. The thiophenic sulphur is practically harmless, and therefore a much higher percentage of this form of sulphur can be tolerated—*e.g.*, in gasoline—than the thiophanic sulphur. According to these experiments the last-mentioned sulphur compound, when added in a concentration of 0·1% S to a normal heptane-*iso*-octane mixture of 65 C.F.R. M.M. rating, will completely neutralize the anti-knock effect of the addition of 3 c.c. tetraethyl lead/gal. of such mixture. On the other hand, the thiophene sulphur added in the same concentration (0·1% S) will lower the above anti-knock rating by three octane points only. A. H. N.

1305.* Nomograph for Density Corrections of American Oils. A. H. Nissan. *Refiner*, October 1941, **20** (10), 407–410.—Based on the data studied by Stott for American petroleum oils, a monogram is presented for their density variation with temperature. A. H. N.

Analysis and Testing.

1306.* Rapid Method for the Determination of Mercaptan Sulphur in Refinery Caustic Soda Scrubbing Solutions. Anon. *Refiner*, September 1941, **20** (9), 393.—A rapid method utilizing the reagents and apparatus found in a small laboratory has been developed. This method can also be used on refinery or natural gases for the determination of mercaptans, by passing a known volume of the gases through a caustic-soda solution and then proceeding in the usual manner. The method outlined in this paper is essentially the reverse of the scrubbing operation in the plant. The mercaptans are forced into the hydrocarbon phase, where they are determined by one of the two commonly accepted methods for mercaptans in gasoline.

Spent caustic-soda solutions were analysed by an adaptation of the method of Willard and Fenwick and by the method in question. The comparison of the results

of the two methods is not in close agreement, but is accurate enough for ordinary control work. However, if the reagents are chilled, much better agreement is obtained.
A. H. N.

1307.* Portable Unit Measures Gas for Gasoline Content. Anon. *Refiner*, September 1941, **20** (9), 394.—Mounted in the coupé back of the driver's seat are a gas scrubber, a two-stage compressor (consisting of a vacuum pump and a high-stage cylinder), gas meter, pressure gauges, mercury manometer, filter, and condenser.

After a metered quantity of gas has been processed through the plant and the gasoline extracted and collected in a graduate, the liquid is heated by means of car-engine temperature to the standard 60° F. and the volume in cubic centimetres at that temperature read off.

The accuracy of the apparatus is claimed to be very high. A. H. N.

1308.* Prediction of Ignition Points of Diesel Fuels in the Laboratory. G. Vorberg. *Refiner*, October 1941, **20** (10), 423–424.—The following indices for ignition characteristics have been employed and compared in forty-two oil tests of various origins: (1) content of hydrogen; (2) aniline point; (3) diesel index; (4) cetene value (determined by Marder's density method); (5) cetene-cetane number, determined in I.G. test motor; also in C.F.R. test motor, as a comparison for above four tests.

Summarizing the results of forty-two oil tests, it has been shown that the diesel index and the cetane value (by Marder) are well adapted to laboratory methods for determining the fuel or ignition characteristics of diesel fuels, which are widely distributed and used in commerce and industry. A. H. N.

1309.* Short-Cut Analysis. B. G. Adams. *Refiner*, October 1941, **20** (10), 426.—A brief description is given for four tests which, it is claimed, are extremely quick to perform. The tests are for determination of (1) doctor treatment improvements—mercaptan; (2) lead; (3) sulphur; and (4) specific gravity of gases. A. H. N.

1310.* Samples of Gas-borne Particles. Anon. *Engineering*, 1941, **152** (3945), 141 and (3947), 181.—The apparatus and technique for the analysis of gases for suspended solids and oil mists are described. It is concluded that Stillite filters are suitable for particles of diameter greater than half a micron, but an electrostatic precipitator is required for particles of smaller size. The design of baffles capable of rendering the gas–dust system homogeneous for sampling or mixing purposes is discussed.
J. W. H.

Motor Fuels.

1311. Motor Fuel Patents. Phillips Petroleum Co. E.P. 538,645, 12.8.41. Appl. 20.12.39. Improved catalytic methods of treating petroleum oils, such as straight-run and cracked gasolines, pressure distillates, naphthas, polymerized gasolines and natural gasolines, to produce an improved type of motor fuel. The gasoline stock is contacted in the vapour form at a pressure between atmospheric and 100 lb. per square inch, with a bauxite catalyst impregnated with a solution of chromium compound subsequently converted to the oxide. The treated vapours are split into two streams, one of which is recycled back into heated raw vapours prior to entry into the catalyst chamber. Decomposed impurities are separated from the other stream, also the light gas fraction containing a substantial proportion of hydrogen gas. In this way hydrocarbons boiling within the gasoline range and having improved anti-knock characteristics are obtained.

Standard Oil Development Co. E.P. 538,715, 14.8.41. Appl. 6.11.39. Method of production of saturated hydrocarbons by the reaction between saturated hydrocarbons containing tertiary carbon atoms and olefins. The invention relates particularly to the embodiment of this reaction in the production of hydrocarbons boiling within the gasoline range and containing a considerable amount of *iso*-octane and fractions suitable for aviation gasoline.

P. Miller. U.S.P. 2,252,089, 12.8.41. Appl. 27.12.39. Preparation of a motor fuel consisting of a hydrocarbon fuel base blended with sufficient of an *N*-alkylated aromatic amine to improve substantially anti-knock characteristics. The amine contains in the aromatic nucleus an aliphatic substituent radical in which oxygen is linked to carbon as in an ester group, and boils within the boiling range of the hydrocarbon fuel base.

L. Heard and A. G. Oblad. U.S.P. 2,252,927, 19.8.41. Appl. 31.3.39. Production of high anti-knock motor fuels from a low anti-knock gasoline by incorporating at least one nitro-aromatic hydrocarbon in the gasoline in sufficient amount to yield a quantity of aromatic amine which will substantially increase the knock rating of the gasoline. Simultaneously the low anti-knock gasoline is dehydrogenated and the nitro-aromatic hydrocarbon converted into an aromatic amine.

R. Rosen. U.S.P. 2,256,627, 23.9.41. Appl. 31.10.39. Preparation of a motor fuel consisting of a major proportion of gasoline hydrocarbons and an unsaturated ether selected from the group consisting of divinyl ether and dimethallyl ether. The ether is blended with the hydrocarbons in sufficient amount to improve the octane value.

A. R. Goldsby. U.S.P. 2,257,074, 23.9.41. Appl. 8.7.39. Manufacture of high anti-knock motor-fuel hydrocarbons by catalytically converting a mixture of carbon monoxide and hydrogen to a synthetic hydrocarbon mixture composed mainly of hydrocarbons having from 1 to 10 carbon atoms per molecule. These hydrocarbons are composed largely of normal olefins, and are comparatively free from aromatic and naphthenic constituents. Gasoline hydrocarbons boiling up to about 390° F. are separated from the mixture and reacted with a paraffin hydrocarbon fraction comprising *iso*butane, in the presence of sulphuric acid, and in the absence of *iso*butylene and aromatic hydrocarbons. In this way *iso*butane is alkylated to produce normally liquid saturated hydrocarbons having a high anti-knock value and boiling within the motor-fuel range.

Le R. G. Story. U.S.P. 2,257,079, 23.9.41. Appl. 4.2.37. Preparation of an anti-knock gasoline, stabilized against gum formation by subjecting cracked hydrocarbons containing unsaturated constituents to contact with a solid absorption catalyst under polymerizing conditions of temperature and pressure and in the presence of a phenol. The phenol is caused to react with at least a portion of the unsaturated constituents, and forms an anti-oxidant reaction product, together with hydrocarbons of gasoline boiling range.

R. Rosen. U.S.P. 2,257,194, 30.9.41. Appl. 18.10.39. Preparation of a motor fuel consisting of a gasoline hydrocarbon fuel to which has been added a minor proportion of a hydrocarbon borine-amine product.

J. W. Teter. U.S.P. 2,257,434, 30.9.41. Appl. 17.8.37. Preparation of a motor fuel consisting of gasoline and a small proportion of a compound of the group consisting of 4-nitroso-2-methyl phenol, 4-nitroso-2-ethyl phenol, and 4-nitroso-2 : 5-dimethyl phenol. H. B. M.

Lubricants and Lubrication.

1312.* Temperature and the Lubricating Properties of Greases. D. Tabor. *Engineering*, 1941, **152** (3946), 178.—A method of analysis of the friction forces between moving surfaces has been developed. The principle involved is that of sliding a metal plate against a loaded stationary hemisphere. The frictional force is measured by the deflection of an arm attached to the hemispherical surface by means of a moving film camera. Two types of motion are found to occur : (*a*) continuous smooth sliding, and (*b*) a series of jerks. It is shown by photomicrographs that when the latter motion occurs, considerable wear of the sliding surface takes place. With this apparatus it is possible to measure the frictional conditions at temperatures and loads similar to those encountered in practice and to examine the effect of dopes on greases. J. W. H.

1313.* Lubricating Oil Addition Agents. O. M. Reiff. *Industr. Engng Chem.*, 1941, **33** (3), 351.—Wax-substituted hydroxy-aromatic hydrocarbons formed by the con-

densation of a hydroxy aromatic hydrocarbon with a chlorinated paraffin wax by the Friedel and Crafts reaction are the starting materials used in the synthesis of multi-functional lubricating-oil addition agents. Details of the method of synthesis of these compounds are given and their structure is discussed. The wax phenols are shown to be good pour point depressants. The introduction of metal substituents into the wax-substituted hydroxy-aromatic hydrocarbon results in an improvement in the pour point depressant value and a highly effective anti-oxidant action is imparted. For example, the addition of ½% of a "wax phenol" lowers the pour point of an oil by 20° F. and the addition of the corresponding wax cobaltous phenate results in a 35° F. lowering of the pour point. Tests in a C.F.R. engine showed that the latter compound greatly decreased the ring-sticking tendency, lowered the carbon deposits, and decreased the neutralization number. The synthesis of metal derivatives of the wax-substituted phenolcarboxylic acids are discussed, and it is shown that these compounds are similar to the metalloxy-compounds in their pour point depressing action and their oxidation inhibiting properties. In addition, these metalloxy derivatives are V.I. improvers. J. W. H.

1314. Contact of Colliding Surfaces and the Influence of Lubricant Films. F. P. Bowden and D. Tabor. *J. Counc. Sci. Ind. Res. Austral.*, 1941, **14** (2), 152–160.—The condenser discharge method has been used to measure the contact period of colliding metallic solids, while measurement of electrical conductance between the metal surfaces has been utilized to study the nature and area of contact. When the surfaces are separated the conductance is zero, and as they come together the conductance rises to a maximum. The conductance at any instant is a measure of the area of contact. A cathode-ray oscillograph was used to record the changes. The break is much more rapid than the make, indicating that plastic flow of the metal takes place. With specially hardened tool steel and small velocities of impact, the collision is more nearly elastic. The presence of a lubricant such as a fatty acid may have little or no influence on the time or area of contact, provided the viscosity of the lubricant is low. If a lubricant of higher viscosity is used it may prevent metallic contact. The time of impact is so short that the oil is not able to escape from between the surfaces. Although the surfaces do not touch, the forces transmitted through the oil film may be sufficiently great to cause plastic flow and permanent deformation of the metal surface. T. C. G. T.

1315.* Better Lubrication with "Roughened" Motor Bearings. Anon. *Nat. Petrol. News*, 20.8.41, **33** (34), R. 262.—Whereas formerly engine crankshaft bearings have been finished to "mirror smoothness" in which surface irregularities had a maximum depth of 5–6 micro (10^{-6}) inches, one plant has now standardized a "rough" finish in which the surface irregularities have a maximum depth of 60 micro inch. The composition of the shaft, bearing, and oil have been unchanged, but better lubrication, longer life, and less wear are stated to have resulted. Tests showed that an advantage was gained up to 60 micro inch "roughness," after which bearing wear again increased. The effect is explained in the assumption that the scratches which constitute the roughness function as tapered grooves to facilitate the transfer of oil to sites of high bearing pressure. H. G.

1316.* Oil Company Developed Process for Etching Bearing Surfaces. Anon. *Nat. Petrol. News*, 20.8.41, **33** (34), R. 264.—Steel bearing surfaces are etched by treatment in a bath consisting of 50%-wt. NaOH and 1%-wt. S at 250° F. Certain constituents of the steel—for instance, ferrite—are dissolved selectively to produce depressions approximately 80 micro inch deep. Data on film strength and wear as obtained from laboratory dynamic testing machines indicate that such etched surfaces show an advantage from the point of view of all desirable characteristics. These observations have been confirmed by tests under service conditions. H. G.

1317.* Tests Showed Matt Finish Provided Best Lubrication. H. Shaw. *Nat. Petrol. News*, 20.8.41, **33** (34), R. 266.—The author describes a series of experiments designed to illustrate the advantage of matt surfaces in bearings as opposed to a mirror finish and to demonstrate his theory that when a matt finish is produced by normal service

the mechanism of the etching action is attrition, due to turbulence in the lubricant stream set up by slight random irregularities in the surface. It is concluded that a matt finish for bearing surfaces provides the most efficient lubrication, but that the action of heavy loads is to polish out this finish except under certain prescribed conditions. H. G.

1318. Lubricants and Lubrication Patents. Standard Oil Development Co. E.P. 537,615, 30.6.41. Appl. 27.12.39. Preparation of a grease composition particularly suitable for use at temperatures above 300° F. Raw rapeseed oil or the acids obtained therefrom are saponified with caustic soda in the presence of mineral lubricating oil while heating to dehydrate the mixture. Additional mineral lubricating oil is added and the mixture stirred and heated to 480–520° F. The mixture is then cooled. During dehydration a small amount of an oil-soluble alkali metal, is incorporated.

Standard Oil Co. E.P. 537,816, 8.7.41. Appl. 3.10.39. Preparation of a lubricant consisting of a hydrocarbon lubricating oil in which is incorporated a metal phenate with a phenolic radical having more than ten carbon atoms. It is claimed that the composition is more stable to heat and resistant to deterioration at high temperatures than the original oil. It is specially suitable for use as a heat transfer fluid where it is desirable to prevent the formation of a deposit on the metal surface from or to which heat is being conveyed.

C. C. Wakefield & Co. E.P. 538,159, 23.7.41. Appl. 18.11.39. Preparation of a lubricating composition, particularly suitable for use under extreme pressure conditions, consisting of a lubricating oil and a minor proportion of an organic compound containing at least two halogen atoms and at least one nitro-group in the molecule, and which may be further substituted only by oxygen-containing groups.

Standard Oil Company of California. E.P. 538,474, 6.8.41. Appl.15.11.39. Preparation of a lubricant consisting of a hydrocarbon lubricating oil in which is incorporated a heavy metal salt of a substituted oxy-acid of phosphorous containing an organic substituent. Preferred acids are substituted orthophosphoric acids, and preferred salts comprise the aluminium, calcium, barium, and chromium salts of these acids.

Armour & Co. E.P. 539,186, 1.9.41. Appl. 7.12.39. Preparation of a mineral lubricating-oil composition containing, as a pour point depressor, an acylated indene wherein the acyl-group contains at least twelve carbon atoms.

E. A. Ocon. E.P. 539,191, 1.9.41. Appl. 24.2.40. Method of recovering high-grade lubricating oils from inferior stocks by subjecting the stocks to a de-asphaltizing process, dewaxing the oil which has been de-asphaltized, and selectively separating from it a relatively more paraffinic fraction. The extracted constituents are subject to differential separation. In this way desirable lubricating-oil constituents of cyclic and unsaturated character are obtained.

C. F. Prutton, A. K. Smith, and D. R. Frey. U.S.P. 2,251,953, 12.8.41. Appl. 6.3.39. Preparation of a lubricating composition consisting of a major proportion of a mineral oil and a small amount of an oil-soluble, phosphorus-containing product resulting from the reaction of PCl_3 with a compound of the class consisting of lactic acid, esters of lactic acid, and salts of lactic acid.

J. G. McNab and W. T. Watkins. U.S.P. 2,252,087, 12.8.41. Appl. 20.9.38. Preparation of a lubricant consisting of a mineral lubricating oil, a soluble soap of a polyvalent metal of the second to the eighth group of the periodic table, and the acids produced by the air oxidation of petroleum oils and waxes. The lubricant is substantially free of oxy-organic impurities of the class consisting of esters, lactories, lactides, and free acids of the type used in preparation of the soap. In addition, 0·25–1·5% of a free saturated fatty acid selected from the class of stearic and margaric acids is added.

C. F. Prutton. U.S.P. 2,252,674, 12.8.41. Appl. 23.3.38. Manufacture of a lubricating composition consisting of a mineral lubricating oil and an amount up to 20% of a

composition selected from the following class: the reaction product of a complex organic wax of mineral origin and a phosphorus- and halogen-containing reagent in which the phosphorus has a valence of three or less; the reaction product of a complex organic oil of mineral origin and a phosphorus- and halogen-containing reagent in which the phosphorus has a valence of three or less. The total amount of phosphorus in the lubricating composition is less than $\frac{1}{10}$%.

C. F. Prutton, A. K. Smith, and D. R. Frey. U.S.P. 2,252,675, 12.8.41. Appl. 6.3.39. Manufacture of a lubricating composition consisting of a major proportion of a mineral oil and a minor proportion of an oil-soluble product resulting from the reaction of a hydroxy-ester with a phosphorus- and halogen-containing compound of the type in which the phosphorus is present in the tri-valent form.

W. A. Whittier. U.S.P. 2,254,337, 2.9.41. Appl. 23.9.38. Preparation of a lubricant consisting of mineral lubricating oil, a phosphorized fatty oil, and a stable highly halogenated aliphatic hydrocarbon having a boiling point not much lower than 180° C.

E. Lieber. U.S.P. 2,254,433, 2.9.41. Appl. 9.9.38. Preparation of a lubricant consisting of a lubricating oil to which has been added not more than 2% of a pour point depressing polyester formed from a polyhydroxy aliphatic alcohol with a long hydrocarbon chain and a polycarboxylic aromatic acid.

J. M. Musselman. U.S.P. 2,254,490, 2.9.41. Appl. 7.7.39. Preparation of a lubricant to which has been added a small amount of a diarylethylenediamine compound of a halogenated carboxylic acid having at least six carbon atoms.

E. Segessemann. U.S.P. 2,254,756, 2.9.41. Appl. 18.6.38. A sulphurized unsaturated aliphatic alcohol having at least eight carbon atoms is used as a sulphur carrier for lubricants.

C. F. Prutton and A. K. Smith. U.S.P. 2,255,085, 9.9.41. Appl. 21.11.41. Preparation of a lubricating composition consisting of a major proportion of a mineral lubricating oil and a minor proportion of a halogen and oxygen-bearing compound of the class consisting of halogen-bearing aromatic acids, halogen-bearing esters of aromatic acids, and halogen-bearing salts of aromatic acids.

O. M. Reiff. U.S.P. 2,256,442, 16.9.41. Appl. 9.3.40. Preparation of a lubricating composition consisting of a mineral lubricating oil and a small proportion of an oil-miscible condensation product of a wax-substituted hydroxyaromatic acid in which at least two wax-substituted aryl nuclei are interconnected by at least one atom of an element from the group consisting of sulphur, selenium, and tellurium.

U. B. Bray. U.S.P. 2,257,328, 30.9.41. Appl. 7.12.37. Preparation of a lubricating oil containing 0·6–2·5% of an oil-soluble metal soap of organic acids containing at least ten carbon atoms and adapted to overcome valve and ring-sticking tendencies. Since the oil contains naturally occurring non-corrosive sulphur, it overcomes the corrosive tendencies of the soaps and imparts extreme pressure characteristics.

H. G. Vesterdal. U.S.P. 2,257,627, 30.9.41. Appl. 29.12.37. Preparation of improved oxidation and sludging resistant lubricating oils by treating a previously refined lubricating oil substantially free from unsaturated materials with a small amount of a boron halide. H. B. M.

Asphalt and Bitumen.

1319. Asphalt and Bitumen Patents. N.V. De Bataafsche Petroleum Maatschappij. E.P. 537,563, 26.6.41. Appl. 8.3.40. Production of bituminous materials with plastic properties and consisting of a mixture of asphaltic bitumens and mineral and/or non-mineral fillers. The asphaltic bitumens have a low-temperature susceptibility, a penetration at 25° C. above 50, and a penetration index above + 7.

J. G. Fife. E.P. 537,567, 26.6.41. Appl. 14.3.40. Manufacture of compositions particularly suitable for road-construction purposes and consisting of sand, clay (with

or without the addition of stone chippings), water, and bitumens. Asphaltic residues are employed as bitumens, originating from mineral oils or mineral-oil products, and containing at least 2% by weight of solid paraffin wax. Alternatively, they may originate from tars containing at least 1% by weight of solid paraffin wax.

International Bitumen Emulsions, Ltd. E.P. 538,690, 13.8.41. Appl. 28.3.40. Method of incorporating a rubber latex mix and bituminous material in textile fabrics. The fibres or yarn or fabric are impregnated with a bituminous emulsion, and then with latex or a mixture of bituminous emulsion and latex. For example, a white jute canvas may be coated with an emulsion consisting of 15% of oxidized bitumen (20 pen., softening point R. and B. 180–200° F.), 15% of oxidized bitumen (200 pen.), 10% casein, 2% ammonia (880), 55% water, 1% preservative (*e.g.*, cresylic acid), and 1% insolubilizer (*e.g.*, hexamine).

A. H. Batchelder, U.S.P. 2,252,111, 12.8.41. Appl. 12.11.38. Manufacture of asphalt from a charging stock containing asphaltenes, oily constituents, and asphaltic resins. The oily constituents are separated out and air-blown. In this way additional asphaltenes are formed without converting the asphaltic resins in the charging stock into asphaltenes. Afterwards these additional asphaltenes are mixed with those obtained from the charging stock, also with the asphaltic resins. H. B. M.

Special Products.

1320.* Aromatics, Gas, and Coke from Heavy Petroleum Residues. E. L. Hall. *Chem. Met. Engr*, September 1941, **48** (9), 100–105.—Processing of petroleum for the production of aromatics is essentially a destructive distillation of high-molecular-weight hydrocarbons into new groupings of simpler structure, accompanied by side reactions and polymerization. Expressed simply, the cracking of petroleum (principally paraffins and naphthenes) follows somewhat this progression: High-molecular-weight paraffins—olefines—(such as acetylenes, naphthenes, polycyclic compounds)—benzol, toluol, xylol, and higher homologues.

It is also true that in any one group the higher-molecular-weight compounds tend to split into lower-molecular-weight compounds, with scission of a radical. For example, butylene–propylene–ethylene, or xylol–toluol–benzol. However, this general trend is also accompanied by alkylation and/or polymerization to produce higher molecular weight compounds—*i.e.*, benzol—naphthalene, or benzol—ethylbenzol.

The effects of temperature, time, pressure, and concentration are treated simply.

Production of gas from oil is similarly studied with the addition of a historical survey of the industry. After describing the work of the company in which the author is chief engineer, the following conclusions are reached:

The gas industry is a logical collaborator of the oil-refining industry for the most advantageous and economic processing of petroleum, a fact which is true principally for two reasons: (1) the gas industry can process petroleum advantageously at operating temperatures suitable for the production of aromatics, since the production of large quantities of gas does not constitute a limitation. (2) The petroleum industry, however, can process petroleum advantageously only to a point where the residues are sufficiently fluid for transportation. If the oil is processed to coke, the local market must be depended on in view of freight limitations. Only in favoured locations are the local markets large enough to absorb the quantities involved.

Thus it seems apparent that the gas industry can with advantage carry on the processing of petroleum from a point where the oil industry leaves off. To be sure, the petroleum industry can produce aromatics by selective extraction of materials containing small quantities of aromatics or by the catalytic cracking of selected hydrocarbons, but it is not believed that such methods can compete with aromatics produced by the gas industry from the heaviest petroleum residues. A. H. N.

1321.* Green Cotton Wax. Anon. *Chem. Tr. J.*, 3.10.41, **109**, 159.—The U.S. Dept. of Agriculture reports the possibility of obtaining high-melting-point waxes from green lint cotton which contains up to 17% of wax, as compared with 0·5% in ordinary cotton. An experimental area of 5 acres is now under cultivation in South Carolina. The cotton has been grown in the south for many years and is used for home spinning

and handicraft work. Exposure of the green lint to sunlight converts it into a dull-brown colour. After removal of wax, the fibre provides a high-grade cellulose. C. L. G.

1322.* New Products from Naphthenic Acids. Anon. *Chem. Tr. J.*, 3.10.41, **109**. 160.—The methyl, ethyl, and *iso*propyl esters of naphthenic acids of acid value 302 and apparent molecular weight 186 have been prepared by Le Roy, Weatherby, and Schiller of the chemical laboratory of the University of S. Carolina.

1000 g. of the acid are refluxed for 3 hr. with a 50% excess of the alcohol and 100 c.c. of conc. H_2SO_4, giving a yield of 85% of the theoretical. The distillation ranges of the three esters were 340–540° F., 365–543° F., and 290–345° F. respectively. Further work is in hand on the reduction of the naphthenic esters to naphthenyl alcohols, and their use in the preparation of emulsifiers and detergents. C. L. G.

1323. Special Products Patents. Standard Oil Development Co. E.P. 537,468, 1.6.41. Appl. 13.10.39. Method of extracting olefines having three and four carbon atoms from mixtures containing these and saturated hydrocarbons. The mixture is contacted with a cuprous halide under conditions designed to ensure that the partial pressure of the olefines in the mixture is greater than the dissociation pressure of the addition compound formed by the reaction between the olefine and the cuprous halide. The residual mixture is then separated from the addition compound.

Standard Oil Development Co. E.P. 537,497, 24.6.41. Appl. 13.10.39. Improvements in the absorption and separation of olefines having two to four carbon atoms to the molecule from mixtures of olefines and paraffins. The invention is designed chiefly to facilitate removal of the heat of formation and supply of heat of dissociation. It also enables time of contact required to absorb an olefine in a cuprous halide to be materially reduced.

Armstrong Cork Co. E.P. 539,077, 27.8.41. Appl. 30.3.40. Manufacture of a tile comprising a filler and a binder in which the binder has a cloud-point between 20° and 100° C., and comprises mineral oil and at least one resin of the class consisting of coumarone resins, indene resins, styrene resins, etc. Mineral oil comprises about 30% of the composition. Suitability of the oil for different resins is judged on the basis of its aniline point.

G. A. Lloyd and E. C. Hermann. U.S.P. 2,252,082, 19.8.41. Appl. 7.3.39. Production of heating oils of increased stability by separating from a cracked distillate boiling in the range 350–650° F. 40–60% of the relatively lower boiling constituents. These are then subjected to an acid treatment of about 2–5 lb. of sulphuric acid (88–98% strength) per brl. of oil. The treated lower-boiling constituents are afterwards blended with the untreated higher-boiling constituents.

E. V. Murphee and E. B. Peck. U.S.P. 2,256,622, 23.9.41. Appl. 29.5.40. Method of controlling the reaction temperature in a process for the manufacture of hydrocarbons containing more than one carbon atom in the molecule from oxides of carbon and hydrogen. A synthesis gas mixture is passed through a plurality of alternate catalyst reacting and cooling zones, and a cooling liquid passed through the cooling zones. The temperature of the gases is maintained within a predetermined range by contact with the cooling liquid. H. B. M.

Detonation and Engines.

1324. Combustion Research in the U.S.A. E. F. Fiock. *Aircr. Engng*, August 1941, 13 (150), 221–224.—A survey is given of combustion research in the direction of improved power output and economy. The author divides the subject under the following headings: (1) The finding of new mixtures which are inherently more powerful or more economical. (2) The finding of new methods of altering the mass rate of burning, the completeness of combustion, and hence the rate of increase in pressure. (3) The prevention of preignition in spark-ignition engines and the promotion of ignition in compression-ignition engines. (4) The suppression of detonation. The paper is illustrated by extracts from recently published work. J. G. W.

1325. Combustion of Tar and its Products. W. Kirby. *Engineer*, 22.8.41, **172** (4467), 122–123.—The difficulties encountered in burning tars and pitches are discussed and various burners are described which are suited to these types of fuel. Some details are given regarding the specification of the products which can be handled by the equipment described. J. G. W.

1326.* Home Produced Fuels for Oil Engines. Report of Home Fuels Sub-Committee of the Diesel Engine Users Assoc. *Engineer*, 29.8.41, **172** (4468), 138–140.—The results of bench and road tests are given, from which the following conclusions are reached: (1) The present designs of transport diesel engine do not readily utilize a straight H.-T. creosote fuel. (2) The addition of a small percentage of one dope improved the suitability of this fuel, 4% being equivalent to the addition of 40% petroleum diesel fuel. (3) A road test with 20% H.-T. creosote blended in petroleum gas oil gave satisfactory performance. (4) Whilst difficulties arise in connection with starting up on L.-T. fuel it is possible to run certain types of engine on this product. (5) Dopes in L.-T. fuel are equally encouraging. (6) Up to 50% L.-T. fuel can be used satisfactorily in blend. (7) Sludging of blended fuels can be avoided by a patent de-sludging process. (8) The quantity of L.-T. crude immediately available is of the order of 1,050,000 gal. per annum. J. G. W.

1327.* New Method of Testing the Knocking Qualities of Motor Fuels. Anon. *J. Inst. Fuel*, August, 1941, **14** (79), 253 (abridged from *Oel und Kohle*. Reprinted from *World Petroleum*, May, 1941).—The C.F.R. method of testing fuels will rate them correctly as far as concerns the C.F.R. engine, but the ratings will not necessarily be the same in other engines or in the same engine under different operating conditions. Road tests developed in the U.S.A. for rating fuels are often far from agreeing with the octane numbers obtained on standard single-cylinder engines.

The octane number as a measure of the knocking of a fuel takes in only a fraction of the time range, and thus the author, with the support of the German authorities, embarked on research to visualize knock throughout its entire extent. An electro-acoustic method was devised in which a microphone attached directly to the engine picked up the noise which could be made visible in a Braun tube or photographed for later examination. An arrangement was incorporated for screening out foreign noises. Besides this, another apparatus was invented by which the intensity of noise could be measured, and it was then practicable to construct and compare knock curves of a test gasoline and a standard reference fuel.

The investigation has demonstrated that it is possible to show the behaviour of each cylinder in a multi-cylinder engine on the same picture.

The author emphasizes that it should be the object of engine-builders to create engines that are less prone to knock instead of fuel producers straining to produce fuels of higher octane rating. He suggests standardization on a 74 O.N. fuel.

Work on this new method for rating fuels has now crystallized in the construction and demonstration of a portable instrument that without difficulty can be used on any type of automobile. A photograph of this apparatus is included and its method of attachment illustrated. The chief result of the road tests so far carried out is to confirm that the cylinders in a multi-cylinder engine may not be behaving in a similar manner with regard to knocking phenomena. Thus adjustments may be made and the overall efficiency of the engine improved. D. L. S.

1328.* Automatic Control of Internal-Combustion Engine Temperatures. W. A. Sawdon. *Petrol. Engr*, July 1941, **12** (11), 19.—In some recent installations of I.-C. engines in the oil industry, temperature control has been obtained by regulation of the flow of air through the radiator, and not by the usual method of thermostatic control of the liquid circulation system. Such engines operate under widely varying loads and at extremes of atmospheric temperature, and the requirements are not merely to cool the engine under maximum heat-producing conditions, but to maintain the desired engine temperature at all times. Control of the flow of air, giving positive results, has been effected by automatically varying the pitch of fan-blades, applying the principles used in controllable pitch propellers of airplanes. The control is effected by a thermostat mounted in the hub, the thermostat containing a special

liquid selected for suitability at the predetermined temperature. A power saving is obtained over conventional fans, and the seriously detrimental effects of over-cooling upon both oil and engine are avoided. Further, since the temperature control is by air-flow regulation, there is constant circulation in the liquid system, and hence there is no hazard of cracking the cylinder block by a sudden inrush of cold water. Actual examples are quoted and illustrated, showing benefits obtained by using variable pitch fans—viz., a power-generating plant in Los Angeles, an oil-well pumping engine, an engine used in bailing service, etc. J. C.

1329. **Diesel Engines Underground. III.—Effect on Exhaust-Gas Composition of operating Engines in Mixtures of Normal Air and Natural Gas.** M. A. Elliott, J. C. Holtz, L. B. Berger, and H. H. Schrenk. *U.S. Bur. Mines, Rep. Invest.*, No. 3584, September 1941.—It frequently happens that diesel engines have to operate underground where composition of the atmosphere differs from that of normal air because of the presence of exhaust gas or, alternatively, of hydrocarbon gases given off by the strata in the underground workings. This report deals specifically with the effect on exhaust-gas composition of operating two 4-stroke diesel engines in mixtures of normal air and natural gas. Concentrations of natural gas used in the course of experiments ranged from 0·2 to 4·7% by volume, and the engines were operated at different speeds and power outputs within the normal operating range of each engine. Concentration of natural gas in the intake was maintained lower than that corresponding to the lower inflammable limit in air at atmospheric pressure and temperature.

It was found that when natural gas was introduced, concentrations of carbon monoxide, aldehydes, and oxides of nitrogen in the exhaust gas generally were much greater than when the intake consisted of normal air. Further, greatest increases in concentration of carbon monoxide were observed when the engines were running at full throttle—*i.e.*, at the maximum fuel–air ratio in the normal operating range. Carbon monoxide concentration was also increased when natural gas was added to the intake with the engines running at constant speed and power output—*i.e.*, at a constant ratio of reacting fuel to air.

Conclusions reached as a result of these experiments indicate that the concentration of natural gas in the intake of the engines could reach 0·5% by volume without necessitating an increase in the quantity of air required for ventilation under normal atmospheric conditions.

While admitting the somewhat limited scope of this report in so far as studies of combustion in the engine are concerned, the authors nevertheless suggest that the addition of combustible gases to the intake may be a valuable experimental technique in studying combustion in the diesel engine, and in obtaining data on the inflammable limits of combustibles under conditions existing in internal-combustion engines. It is suggested that such possibilities should be further investigated, and also that the addition to the intake of other gases, such as carbon monoxide and hydrogen, in concentrations lower than that corresponding to the lower limit of inflammability, should be studied in relation to combustion in the diesel engine. H. B. M.

BOOK REVIEW.

Regulation of Pipe-lines as Common Carriers. By William Beard. 1941. Columbia University Press (English agents: Oxford University Press). 184 pp. 13*s.* 6*d.*

The regulation of American pipe-lines as common carriers, on the analogy of the common carrier status of railways, dates back to legislation of 1906. Intermittent disputes between railroads, large oil corporations, small independents, and land-owners had been going on since 1885, and by 1905 had grown into a demand for Government intervention. In 1906 the position was clarified to some extent by Congress legislation, which placed the responsibility for the regulation of certain aspects of pipe-line operation upon the Interstate Commerce Commission. The Commission is primarily concerned with railroad regulation, and the railroad concept of transportation came to be applied to both carriers, on the theory of similarity in function. At first the Commission was concerned only with accounting procedure. Subsequently its control was extended to rate-fixing, definition of status, regulation of services at collecting and delivery points, and co-ordination with rail and sea transport. In 1938 the mileage of oil pipe-lines recognized by the National Government as common carriers and reporting to the I.C.C. was 95,973 out of an approximate total mileage (excluding natural gas lines) of 115,000.

Whether the application of the historic concept of the common carrier to a modern instrument of technology to which it is poorly adapted is justified or not is a matter of opinion. Mr. Beard puts forward no personal views, but ably summarizes the pros and cons of the common-carrier status. The extraordinary fact is that the evolution of the industry has been such that:

> "Though tens of thousands of miles of pipe lines serving the mineral industries have become common carriers on paper, they are only to a very limited extent common carriers in fact. Some such pipe lines are entirely devoted to moving fluids owned by the interests controlling the lines, while other facilities carry only a small percentage of freight for outsiders, meaning the public generally. True, there are lines that are operated largely or exclusively as common carriers for the general public, but these independents are of decidedly secondary importance in the total situation."

From the fact that only two formal complaints regarding pipe-line rates and services have been filed with the I.C.C. between 1906 and 1939, it appears that the best form of legislation has been one of benevolent non-interference.

On the one hand, pipe-lines can be regarded as transportation agencies moving freight in competition with carriers by rail and water. This view has predominated in public policy. On the other hand, lines may be regarded as an extension of the plant facilities of an integrated company. This view prevails in fact, and makes for efficiency in processing and ultimate public benefit.

The author's treatment throughout is on legal and historical lines; but he does not lose sight of the implications of possible future technical developments. For example, the introduction of alternative freights, such as synthetic alcohol, hydrogenated coal, or pulverized coal suspended in a liquid medium, are discussed as possibilities that may radically alter the present status of the pipe-line. His book is an unbiased and well-documented chronicle of conflicting policies and enactments during the past 35 years. It is topical as bearing on the national defence programme of U.S.A.; and it is deserving of study in any other country that may be faced with problems of pipe-line regulation.

S. J. Astbury.

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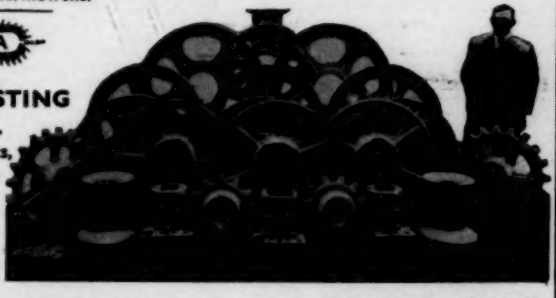

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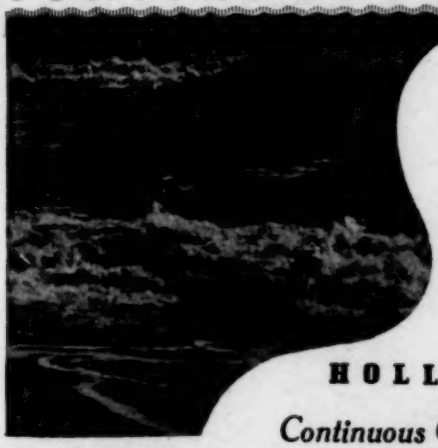

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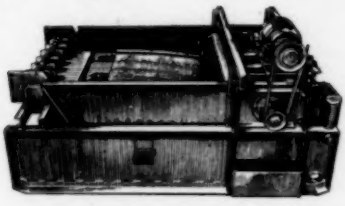

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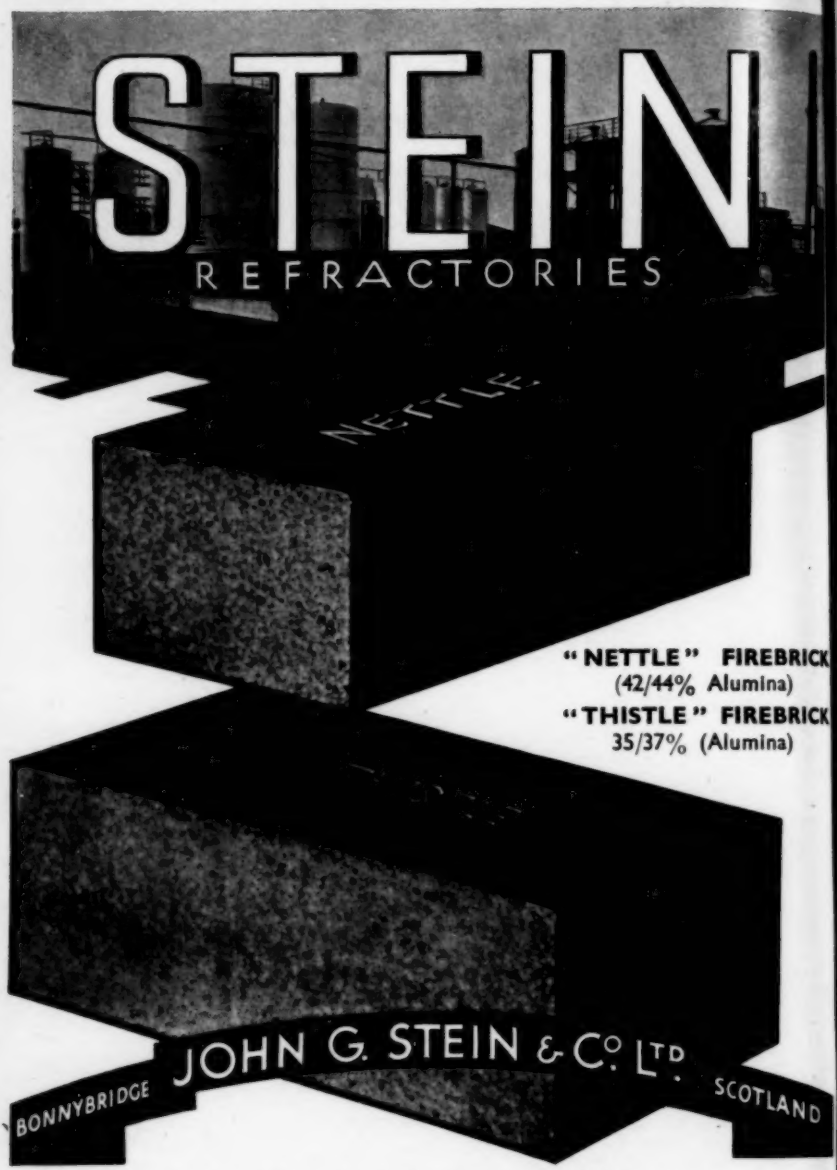

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Specially designed
UNDERGROUND TANKS

A complete range of designs
to suit site requirements.

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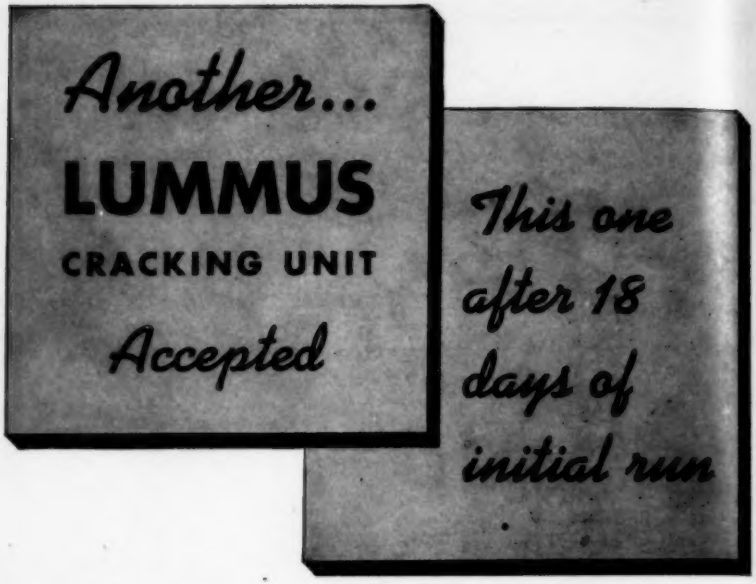

For a major oil company Lummus recently completed a Lummus Combination Three-Coil Cracking Unit . . . viscosity-breaking, gas oil and heavy naphtha reforming. » » » Eighteen days after the unit was put on stream it was completely accepted, having met all guarantees. The initial run was continued to 25 days, when the unit was shut down for inspection purposes. » » » This recently completed unit — the ninth consecutive Lummus Cracking Unit to be accepted during initial firing runs of 25 days or more — is equipped with Lummus Floor-Fired, Raised Hearth Heaters, with improved steam generation feature in the convection section. Provision is also made for steam generation from waste heat.

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Representing: **THE LUMMUS COMPANY**

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"We drilled 2,000 feet 'BEYOND' and still had good performance"

BENDER DRILLING CO.
CONTRACTORS OF OIL DEVELOPMENTS

February 14, 1941

Cardwell Manufacturing Company, Inc.
P. O. Drawer 8001
Wichita, Kansas

Gentlemen:

We are glad to send this report on our "Cardwell" Model S twin-engine drag works.

First, let me say we are very pleased with the entire set-up, especially as the rig drilled this well to 7,000 feet. This is 2,000 feet beyond your recommended depth with Waukesha GAK engines.

The drillers liked the draw works from the start. It is light and compact, even with both engines assembled, making rigging up much easier. The air controls, even-step transmission and Hi-Speed drive saved them much time and effort.

In checking the round trip time, the following results were obtained; at 7,000 feet, we had 46 stands of 4-1/2" and 22 stands of 5-1/2" drill pipe in the hole. We pulled a stand every 2 minutes and 20 seconds in low gear; 2 minutes in second gear; 1 minute and 20 seconds in third; 1 minute and 15 seconds in fourth. Coming out at 7,000 feet we pulled 15 fifth. We second gear; 21 in third; 21 in fourth and 22 in fifth. We cannot give you the exact time as we could figure, it took to change tongs, etc., but as near as we could figure, it took 2 hours and 20 minutes to pull out from bottom, 7,000 feet.

Going in, we run at the rate of one stand per minute average all the way, or 78 stands in 78 minutes. The drillers all agreed that the brakes are the best they have ever used, as they held the load nicely even at 7,000 feet.

We hope this report will be of value to you, and remain,

Yours very truly,

E. A. Bender

EAB:BB

TWIN-ENGINE MODEL S FEATURES

"Cardwell" five-speed, over-centre transmission drives to the drum and rotary table through friction clutches.

Friction clutches are air-controlled.

Air-controlled Hi-Speed drive operates outside of transmission for quick "hook-up" of block.

Power take-off friction clutches are air-controlled.

Draw works can be moved complete without removing engines.

When rotating, the drum may be uncoupled and the drill pipe lifted without stopping the rotary table.

Dual safety, self-energizing brakes.

Heat-treated brake flanges have water-trough for quick cooling.

Sand line drum is available with rig or for hold installation at later date.

*Twin-engine Model S is available with two Waukesha GAK, Waukesha WAK, Cummins HP-600, Cummins HPS-600 (Supercharged), or "Caterpillar" D13000 engines.

EXPORT OFFICE
CARDWELL MFG. CO. INC.
Wichita, Kansas, U.S.A.

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FOR:

Atmospheric and Vacuum Distillation

Cracking

Reforming

Reversion

Stabilization

Chemical Treatment

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SPECIFY "PITTSBURGH SPECIAL DOUBLE GRIP" DRILL PIPE FOR SUCCESSFUL DRILLING

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Used in drilling the deepest wells on record, "Pittsburgh Special Double Grip" Drill Pipe provides the extra success factors and protection required by drillers on the most exacting jobs.

"Pittsburgh Special Double Grip" Drill Pipe conforms strictly to A.P.I. specifications regarding pipe sizes, grades of steel, thread dimension, form and taper—plus its *exclusive patented* advantages.

The patented "Double Grip" pipe and tool joint result in *increased* gripping power of the counterbore as the joint is tightened.

Extra "land" area beyond threads, tapered in exact alignment with the threads, provides more than 35 per cent extra contact surface, relieving the last engaged threads of destructive vibrations and biting.

These features assure a doubly-positive sealed joint, prevent rocking and minimize effects of whipping. All the advantages of shoulder-welding without any of the disadvantages.

Available in either Internal Upset or External Upset-Internal Flush.

Complete specifications and prices upon request.

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deliver a positive reliable and oil free supply of Air or Gas economically and efficiently. Absence of internal contact ensures long life, low maintenance and continuous operation over long periods.

Illustration shows a batch of Blowers recently dispatched to an Oil Refinery

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STORAGE TANKS

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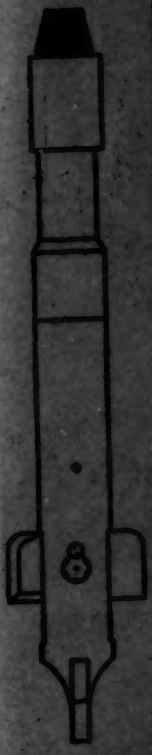

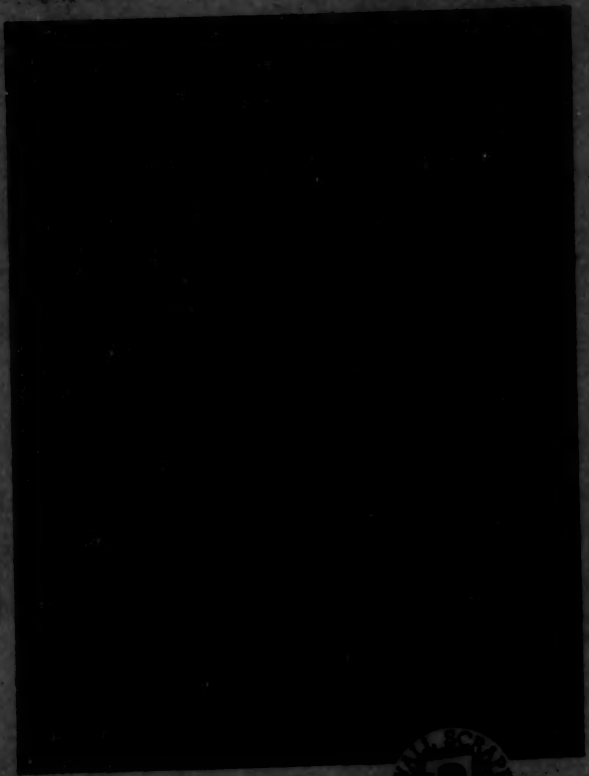

AND DON'T FORGET . . . The Baker Well Sweeper is Really "TWO TOOLS IN ONE" . . . As by merely changing blades, converts the Well Sweeper into a BAKER WALL SAMPLER . . . a device that actually takes cores from the side walls of any uncased hole. For Complete Details Contact Nearest Baker Office or Representative.

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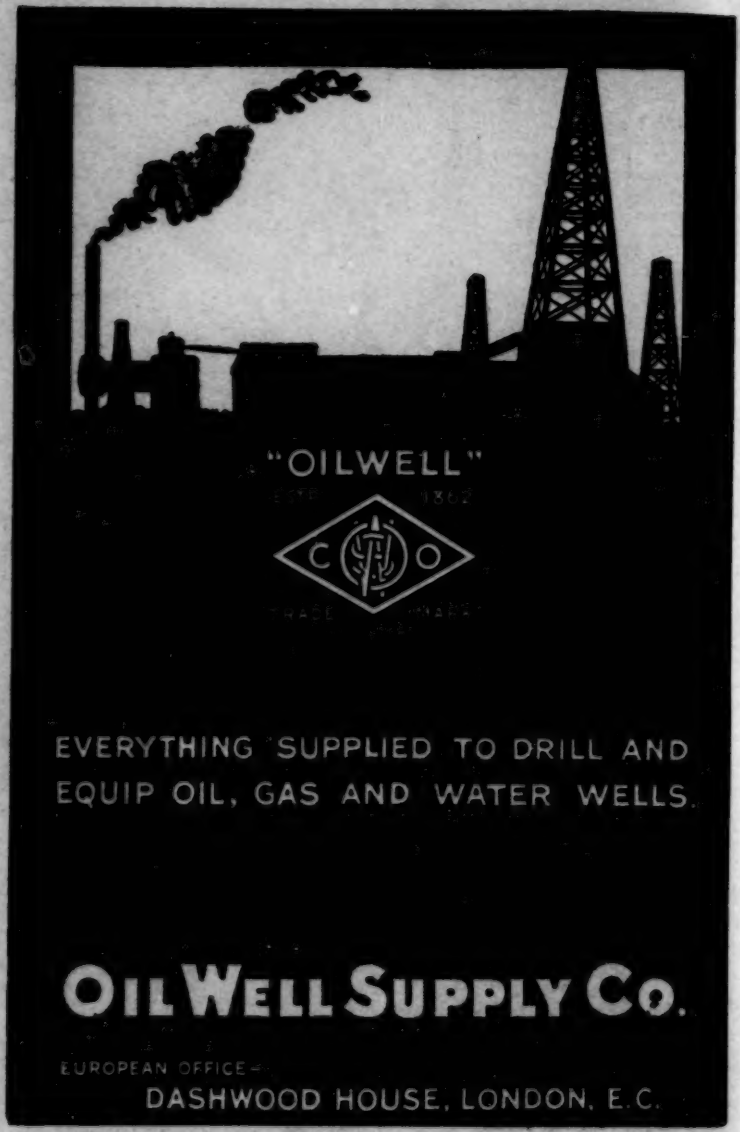

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